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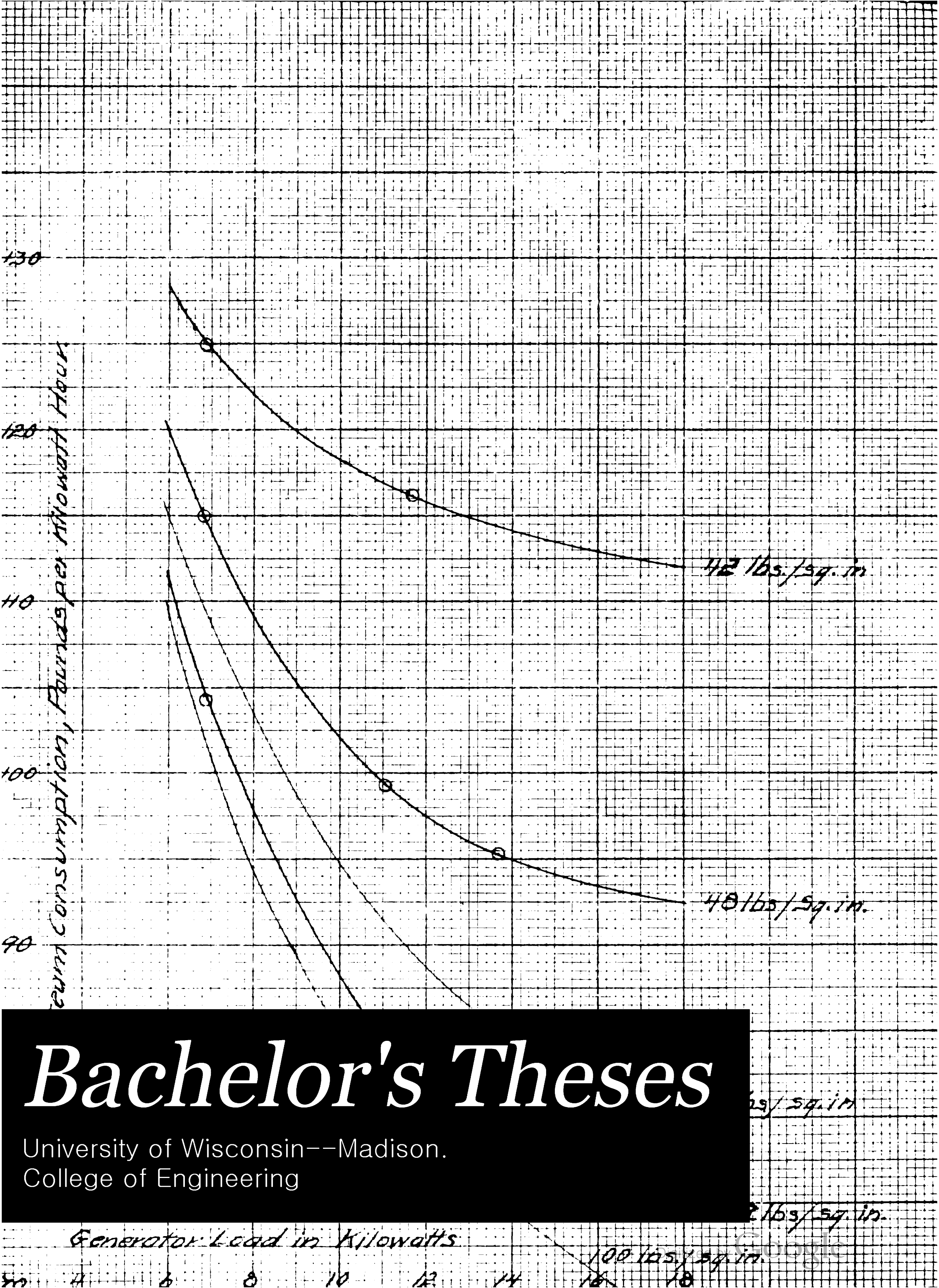

Bachelor's Theses

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A TEST OF THE BAGGAGE CAR SYSTEM OF TRAIN LIGHTING AS USED ON THE NORTH COAST LIMITED TRAIN NORTHERN PACIFIC RAILWAY

By

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FOREWORD.

In writing this thesis on the "Baggage Car" System of train lighting, it is not our intention to give an extended discussion on the general subject of car lighting, but rather to confine ourselves to an actual test.

Since the first use of electricity in train lighting, many very marked advances have been made; in fact, in no other branch of passenger car equipment has there been such marked improvement in the last few years. The most approved methods are the "Baggage Car", the "Axle Drive", and the "Storage Battery" systems.

The older one of the two, the "Baggage Car" system, although used extensively throughout the country, has not been considered satisfactory, and it is the object of this thesis to determine, as far as possible, the actual working conditions so that it may be compared with the "Axle Drive" system which is becoming more and more prominent.

INTRODUCTION.

The traveling public becomes more and more exacting in its demands for safety, convenience and comfort. The traveler of today, though he may have a modest income, demands and secures conveniences and comforts which would have satisfied the most exacting millionare a generation ago. If he cannot get the service from one public carrier, he knows he can secure it from another. The shrewd manager realizes that by catering to the demands for greater safety and comfort to the traveling public, he not only draws traffic from his competitors, but he actually increases the total amount of travel. People who dread a long, tiresome and dirty journey will undertake such only under dire necessity, while they are glad of an excuse to take a trip over a well-appointed road with well-ballasted roadbed and comfortable electric lighted cars.

When the incandescent electric lamp reached a practical form, in 1879, its advantages were immediately recognized, and within twenty-five years it had secured such a strong hold upon the market that over 25,000,000 lamps were required annually to meet the

demand. Consisting, as it does, of a carbon filament heated to a high degree of incandescence in a vacuum maintained within an air-tight glass globe, very little heat escapes to the outside, so that it may be placed safely in almost any location desired. There is no open flame which may set fire to surrounding combustibles, and the temperature is so low that only actual contact for a long time will carbonize or ignite very inflamable material. It heats the atmosphere only to a very small extent, having no open flame. There being no combustion it does not vitiate the air in the least. It can be lighted without matches, and simply by the turn of a key or switch in the hands of any unskilled person may be lighted or extinguished at will and without danger. There is no water vapor given off by combustion to increase the humidity of the air and add to the oppressiveness of a hot, sultry summer night, or even to intensify features of the so-called atmosphere found in some of the sleepers and coaches. There is no smoke, no smell, nor any oil dripping on carpets or on passengers' clothes.

When the electric light was first applied to train lighting, even with the crude apparatus of that

early stage in the development, it was hailed with delight by the traveling public. Not only did they appreciate its many advantages for stationary lighting, but in connection with train lighting the public mind was saturated with the idea that a large portion of the holocausts in connection with railway wrecks, if not started, were at least fed and intensified by the inflammable substance used for car lighting. Even though it might not be certainly proved that the fire was actually started by the lamp or gas, the feeling that it might have been the cause put all classes of flame as light sources in the same category with the deadly car stove, against which much legislation was fired. Occasional explosions here or abroad left no doubt in the public mind as to the desirability of replacing all combustibles by electric light. When the electric berth lamp was introduced, it proved an instant success. A sleeper with berth lamps is sought in preference to all others. Having enjoyed the comfort of a cool diffused light at one's shoulder available at any time during the night without disturbing the porter or any one else, the traveling public is satisfied with nothing less, and today no train can be called thoroughly modern and up-to-date unless it can

advertise electric berth lights and vestibule lights. Along with these lights is the comfort derived from the possibility of having an electric fan to keep the air in circulation and to mitigate the discomforts of an atmosphere otherwise intolerably close at times. Another auxiliary the ladies never forget, is the possibility of heating a curling iron without the dangerous and nerve-trying alcohol lamp; for with trains equipped with storage batteries the ladies' dressing room and each compartment may be equipped with an electric heater always ready for use by simply inserting the tongs. The electric lighted transparencies, or tail lights, make effective advertisements.

Having outlined the advantages and pointed out some of the reasons why electric light equipments are demanded by the public, let us note a few of the various plans that have been tried.

The plans proposed for lighting trains by electricity may be considered under three heads - the use of batteries alone, dynamos alone, and combinations of batteries and dynamos.

The use of primary batteries was attempted for

lighting several trains between 1883 and 1887 in France, England and America. Primary batteries are an ex~~plos~~penive source of energy and can not at present compete with power driven dynamos either directly or through the medium of storage batteries.

The use of storage batteries on trains dates from October, 1881, when a Pullman car running between London and Brighton, England, was equipped with storage batteries which were charged at London during the night by a special engine and dynamo. In April, 1885, the Pennsylvania Road equipped eight parlor cars with storage batteries. The next year witnessed an active campaign by the two storage battery companies then in existence, the Julien Electric Company and the Electrical Accumulator Company, and a number of cars were equipped. The storage battery of that day was far from satisfactory and in several cases battery lighting was abandoned. The Pennsylvania road has continued their use to the present day, the cells being charged from a stationary plant at Jersey City and also en route by an engine and dynamo in the baggage car. The early practice was to run the cars to the charging station, where the exhausted cells were removed and replaced by others freshly charged. This

required much hand labor and the handling was found to be very hard on the cells. The later practice is to charge the batteries while the car is lying in the yard for cleaning or to charge them while the train is running.

The storage battery system, without any other source of power on the train is admirably adapted for trains having a regular run such that the batteries can be charged every day.

For long runs the battery with capacity for lighting the whole train throughout the trip would be too heavy and some provision should be made for renewing the charge en route. Such a system is used on the North Coast Limited train of the Northern Pacific Railway, running between St. Paul and Portland, which is the train under consideration in the following discussion. This train is made up of nine cars, all but two having a storage battery, and the lights divided into several circuits. [See Plate IV.]

During the night the lamps are lighted from an engine and dynamo in the baggage car. When passing through tunnels during the daytime, and when changing engines at night, part of the lights in each car can

be connected with the storage battery. When this system was first installed, the batteries were charged only at each terminal but now it is the custom to charge them every night but the last one east. They are then given a more thorough charge while the cars are being cleaned in the St. Paul Yards. As the cars are liable to be transferred to other trains during parts of the year, each car has an auxiliary equipment of oil lamps.

GENERAL DESCRIPTION.

This company uses a Westinghouse Standard engine directly connected to a Westinghouse dynamo [Plates I and II]. The dynamos are compound wound and maintain the voltage closely constant for all loads at normal speed. The engines are self-governing and keep the speed quite constant. They are less expensive to keep in repair than some other types used but they give more vibration to the train. This vibration from the engine is not perceptible when the train is running, but it becomes somewhat objectionable at times, especially on the vestibuled trains, when standing at stations.

STEAM CONNECTIONS.

The greatest difficulty in connecting the engine with the locomotive boiler is the flexible joint required between the engine and the cars. A flexible rubber hose has been greatly used for the purpose, but on account of the short life of the rubber, a combination of the Moran metallic coupling and Martin flexible joint is coming into more common use. [See Plate III]. This form of coupling is very hard to keep steam tight, but is considered the best to be had at present. We found the greatest trouble in the Martin joint. When the Moran coupling was properly locked, it gave little or no bother. The Martin joint is a form of ball and socket joint, made up of a bell-shaped piece in which is inserted a Vulcabeston moulded packing ring. A globe-shaped enlargement on the other section is clamped into this packing ring and is free to move more or less in all directions. The leaks were caused by the rings which were screwed over the packing ring to hold the smaller section in place, working loose. There were eight of these joints between the tender, mail and dynamo cars which were in constant need of attention and it may be

said that at least one was leaking more or less all the time.

The locomotives used on this train are all of 200# steam pressure, and a reducing valve is therefore necessary in the pipe line. This valve is located in the engine cab and is adjustable. A gauge shows the engineman just what the reduction is. As there are generally from 15# to 20# per square inch loss in pressure, due to friction and condensation in the 1-1/2" pipe line, the pressure at the locomotive, after passing through the reducing valve, should be at least 100# per square inch in order to give normal pressure, 80#, at the dynamo engine. This we found was not always the case as the enginemen were in the habit of reducing the pressure still more when the load was heavy.

WIRING.

The system of wiring used is the equipotential, in which the pressure is practically equal at the lamps and batteries. One wire leads from the positive pole of the dynamo to the rear end of the rear car where it is coupled to a second, which returns to the front end of the first car, but not to the generator. This return wire is tapped by the positive pole of each battery and one side of each lamp circuit. A third wire leads from the negative pole of the dynamo to the rear end of the rear car, where it ends. This third wire is tapped by the negative pole of each battery and the remaining side of the lamp circuits. All the batteries and lamps are therefore in multiple. Double-pole, fusible cut-outs are placed in each circuit and with the switches are located in convenient switch-boxes on each car. The wires are placed in the roof. The connection between the cars is made by bringing the wires from the roof through the hood to the inside of the vestibule, where they terminate in square brass tubes, which are permanently attached to the vestibule frame. The connections between these terminals are made with

stranded flexible cable, equivalent to #00 wire. As these connectors are placed horizontally, it is evident that if the train should for any reason be parted, the connections will be severed without damage to any part of the system.

BATTERIES.

The batteries used on the two trains tested were "Chloride Accumulators", made by the Electric Storage Battery Company. These were placed beneath the center of the cars, the capacity of each varying with the number of lamps on the storage circuits. Following are the sizes of the cells of the two batteries:

Large Size Battery.

Total weight, 1350#.
Capacity, 40 ampere hours.
Discharge rate, 7 amperes.
Number of plates per cell, 7.
Size of each plate, 6" X 5-1/2".
Arrangement, 6 cells in a box.
Total number of cells, 50.
Weight of elements per cell, 19#.
" " electrolyte " " 5#.
" " complete cell, 25#.

Small Size Battery.

Total weight, 980#.
Capacity, 30 ampere hours.

Discharge rate, 5 amperes.

Number of plates per cell, 5.

Size of plates, 6" X 5-1/2".

Weight of cell complete, 17#.

Total number of cells, 50.

DESCRIPTION OF TEST - CALIBRATIONS.

All of the electrical instruments were calibrated before the tests were made and immediately after returning. These calibrations were made by connecting the voltmeters in parallel with the Weston Laboratory Standard voltmeter and the ammeters in series with the Weston Laboratory Standard ammeter. The voltage was then varied by means of a water-box, the voltmeters reading the drop across it and the ammeters the current flowing through it. Simultaneous readings were taken on the similar instruments and calibration curves plotted [curve shats].

The steam gauge used in calibrating the Northern Pacific gauges, was adjusted by comparison with standard weights in the University laboratory before being taken on the trip. It was set on the lubricator piping of the dynamo engine and the steam pressure in the pipe line, the engines not running, was varied by throttling the steam flow through an escape valve in the separator. Simultaneous readings were taken on the secondary standard and Northern Pacific gauge, from which a calibration curve was plotted. The standard was then taken off and all pressure readings taken from the engine gauge. The

University gauge was calibrated again after the tests were made.

The indicator springs used were calibrated hot after the trip by means of steam pressure and a mercury column.

The Indicator motion used was of the crank and connecting-rod type, which reproduced the piston travel in the ratio of one to four. It consisted of a collar fitted on the engine end of the shaft, adjusted so that they were in exactly the same relative position on the shaft as the engine cranks. The length of the connecting rods of this motion were also proportionate to those of the engine, and were connected to two sliding rods, set in a frame, to which the indicator cords were tied, The collar of this mechanism was clamped to the engine shaft by means of set screws which, due to the high speed and vibration of the engine, were not sufficient to hold it rigidly for long periods of time. Trouble was also experienced with the cords themselves, owing to their length and the fact that their direction was charged once by running them over small pulleys. The cords would jump off and wedge between the pulleys and support, hence be broken.

The indicator motion was set by taking off the

crank case cover and one cylinder head, then turning the engine over untill it was on dead center. Dead center was determined by setting a scale on the piston, inside the cylinder and noting its direction of travel. When the engine was on dead center the scale would move in the same direction no matter which way the shaft was turned. The cranks and connecting rods of the indicator motion were then set in the same phase with the engine cranks. We found this setting to be correct from the fact that the respective connecting rods traveled always in the same direction. The cords were made of such a length that the indicator drums would not strike their "stops" at either end of the stroke.

CALIBRATION DATA.

Voltmeters.

Standard.	#16808.	#11851.
December 19, 1905.		
0	.5	0
10.4	10	10
26.3	25.4	26
41.6	40.8	41.8
55.4	54.2	55.8
72.6	70.8	72.2
85.4	84.2	86.1
96.3	95.4	97.2
106.4	105.5	107.7
112.4	111.2	113.7
96.3	95.2	97.2
72.4	71.7	73
55.4	54.5	55.9
29.4	28.8	29.3
January 10, 1906.		
0	0	0
16.1	15.5	16
32	31	32
45.5	45	46

Ammeters.

Standard.	#6966.	#526
January 10 1906.		
35.2	35	31.5
40.4	40	36
52.5	52	51.7
61.2	60.5	59.4
80	79	78
96	95	94
112.4	112	111
130.4	130	129
149.6	150	150

December 19, 1905.

Standard.	#6966.	Stand.	#526.
49	48	26	24.5
64	63	52	50
88	86.6	67.2	65
102.8	101.8	85.2	83
128.8	128.	104	102
148	148	133.2	130.8
		150	148.5

Calibration Data, [Con.] (1)

58.8	58	59.4	120	118.5
69.3	68.7	70	90	88
83.9	83	84.8	70	68
92.1	91.3	93.1		
99.8	99	101		
101.3	100.5	102.5		

Voltmeters #16808 Ammeter #526 used on Car #241,
Trip and Yard.

" #11851 " #6966 " on Car #237,
Trip.

Calibration Data - Concluded.

Steam Gauge, Jan. 2, 1906. Car #241.

Indicator Springs, Jan. 10 1906.

Standard.	Northern P.
95	87.5
89.12	84
84.5	80
80	76.25
75	72.5
70	67.75
65.5	64.25
60.87	60
55	55.5
50.25	51
45.25	47.25
40	42
36	37.75
31.25	38.5
27	30

60# Spring.

Indicated Press.	Mercury Press.
0	Atmosphere.
8.5	4.9
15.3	9.9
24	14.7
31	19.6
36	23.5
49.5	29.4
52	35
60	43.1
65	52.5
71	59.2
73.5	64.5
80.5	71.4
83	78.9
87	89.7
68	70.6
62	65.7
55	53.9
49	50.75
45	46.1
42	41.6
35	36.8
31	31.1
26	26.6
22	21.8
20	19.25
14	16.85
0	Atmosphere.

80# Spring.

Indicated P.	Mercury P.
0	Atmosphere.
8	12.7
15	18.36
17	22.8
28	27.9
35.5	32.95
44	38.7
50	44.6
56	51.7
61	60.6
66	70.6
70.5	78.5
76	80.5
88	87.5
80	83.4
76	79.5
72	68.7
66	63.75
60	57.6
55	54.9
51	51.2
46	46.6
40	40.8
36	37
26	27.15
20	21.7
17	19.35
6	14.8
0	Atmosphere.

TRIP DATA.

One of the main objects of the test was to determine the amount of steam taken from the locomotive by the dynamo engine. To do this exactly it would have been necessary to weigh the steam used on the train, but on account of the lack of condensing water, this was impossible. It was necessary, therefore, to test the engine in the yards, duplicating the working conditions on the run as closely as possible.

In order to determine these working conditions, the steam pressure, load in amperes, voltage and speed were taken every half hour throughout the round trip. The load and steam pressure were found to vary greatly, which can be seen by an inspection of the trip data and accompanying curve sheets. The condensation in the steam pipe and connections was collected in a "Cockrane" separator and carefully weighed each half hour. This varied with the locality to a certain extent, that is, with the kind of water used in the locomotives. Besides keeping a log of the engine and generator data, we also kept track of the length of time the batteries were in use, why they were used and their voltage before and after. It is the custom to charge the batteries the

first five nights of the round trip, This charging is started as soon after twelve o'clock as possible and is continued from one to six hours. The batteries are charged in the St. Paul yards at the end of each trip for four and one-half hours at a 50-ampere rate for the whole train.

YARD TEST.

As stated above, the engine and generator on Dynamo car #241, were tested after the trip, to determine the influence of the variation of steam pressure and load on the steam consumption. In this test we disconnected the engine from the exhaust muffler and hood and in their place connected a surface condenser, giving us facilities for weighing the steam used. Load was applied and varied on the generator by means of a water box, In order to duplicate the conditions on the trip, we made series of runs with varying loads for different steam pressures. This gave us data with which we plotted our steam consumption curves [Sheet 92]. . Knowing the steam pressure and load, by interpolation we could determine approximately the steam consumption per kilowatt-hour at any time on the trip. Multiplying the number of steam per kilowatt-hour by the number of kilowatts load gave us the total amount of steam used per hour by the dynamo engine. In plotting the steam consumption curves, we added the average pipe line loss per hour to the amount of steam used by the engine.

DISCUSSION.

Realizing the fact that the essential value of this report lies in the conclusions drawn, and a brief statement of the basis of these conclusions, we will state them in the following in as brief a manner as possible.

It can be plainly seen that one of the uncertainties connected with the steam supply is due to the absolute dependence upon the mercy of the engineman for steam. The ordinary engineer on locomotives is not so familiar with the action of a constant speed governor as he might be. By referring to the curve sheets it can be plainly seen that to a certain extent everything varied with the steam pressure, when the steam pressure was increased for a given load, was increased instead of being decreased as the engineer intended. For instance,by reference to the curve sheet for the first night West [Car No. 241],at 5;00 P.M., the steam pressure was 67.5#,the load was 12.2 K.W. and the steam consumption was at the rate of 1100# per hour, or 90.3# per K.W. hour. At 5;05 P. M. the steam pressure had dropped off to 40# while the load had increased to 12.75 K.W. and the steam consumption

went up to 1530# per hour, or 120# per K.W. hour. At 6;25 P.M. the steam pressure had increased to 99# and the load to 14.4 K.W., while the steam consumption fell off to 1088# per hour, or 75.6# per K.W. hour.

Again on the first night east [Car No. 241], at 7;30 P.M. the steam pressure was 77# the load 14.6 K.W. and the steam consumption 1210# per hour, or 83# per K.W. hour. At 8;15 P.M. the steam pressure had increased to 92# and for practically the same load the steam consumption had fallen off to 1135# per K.W. hour, or 77.7# per K.W. hour.

Also, referring to the curve sheet for the third night East [Car No. 241], the pressure at 7;30 P.M., was 96#, the load was 15,1 K.W. and the steam consumption was 1170#, or 77.5# per K.W. hour. At 8;00 P.M. the steam pressure was 91#, the load was 14.9 K.W., a decrease of .2 K.W. while the steam consumption had risen to 1240#, or 83.5# per K.W. hour, an increase of 60# per hour, or 7# per K.W. hour, for a decrease in steam pressure of 5#.

A detail study of the curve sheets will show that this is true throughout the test. Data taken on the Pioneer Limited train of the Chicago, Milwaukee & St. Paul Railway, where the same type and size of engine and

dynamo are used, shows that the same variation takes place there, [See page 61]. That is for a decrease in steam pressure at constant load, the steam consumption is increased, which of course, is to be expected.

This increase in the steam consumption, when the pressure is reduced, is due to the fact that the engine governor endeavors to keep the speed constant. To do this the ports are necessarily opened wider and consequently live steam is taken in for a greater portion of the stroke. When the engine lost its governor, as was shown by its pounding, live steam entered the cylinder throughout the whole length of the stroke.

The area of the curves for "Generator load in kilowatts" and steam consumption per hour were taken by means of a planimeter and from these areas the total load, steam consumption and average steam consumption per kilowatt hour were computed for each night. [See page 86].

There is constant liability of the failure of the steam connections, which, if prolonged beyond the capacity of the batteries will result in the use of oil for light.

One chief objection with the method of charging

batteries is the fact that some of the lights are always burning, hence are burned at 115 volts, and some times higher while the batteries are being charged. This high voltage causes a set in the incandescent filament which reduces the length of life and the lighting capacity of the lamp greatly when again burned on the ordinary lighting pressure, 107 volts; when burned on the battery circuit the voltage is still lower, generally about 98, consequently a greater reduction in efficiency and amount of light emitted. The time of charging the batteries is hardly to be improved upon. The batteries during the trip are sufficiently charged at night to keep them in fair shape, while a thorough charge is given them in the yards at St. Paul at the end of each trip. This thorough over-charge is necessary at least every ten days to keep the negative plates from sulphating.

ENGINE DATA

Baggage Car No. 241.

First Night West, December 23 - 24, 1905.

Time.	Volts.	Amp.	Steam Press.	R.P.M.	Sep. water.	Load in K.W.	Steam Cons. /KW.hr.	Total Steam Cons. per hr.	Remarks.
December 23 1905 "Central Time."									
11;10 A.M.	91		37						Got steam 10' after signal St. Paul shed.
11;50 "	108		85						Minneapolis train shed.
4;30 P.M.	103	104	43	296		10.71	120	1283	Engine run 10' before catching governor.
4;35 "	111	110	43	317		12.21	118	1440	
5;00 "	104	107	67.5	363		11.12	94	1047	Loop out at back end of train and in at fore
5;15 "	104.5	105	56	360		10.98	97.5	1070	end of diner.
5;30 "	108	106	60	366		11.44	96	1095	Steam leaking in three places between Exp.and Bagg.
6;00 "	104	118	64	350		12.28	93	1140	and one "locomotive and Exp.
6;05 "	106	121	40	344	53	12.83	123	1580	Governor pounding.
6;22 "	101	112	36	337		11.31	127	1440	
6;25 "	109	123	99	370		13.41	76	1030	Water tank--stopped one
6;30 "	109	122	103	374	10	13.30	75	1000	leak in steam connections.
7;00 "	107	120	91	367	23	12.83	78.5	1010	Tightened all steam
7;30 "	105	119	85	378	16	12.49	81	1010	couplings at Fargo.
8;30 "	106	118	72	266	30	12.5	87	1088	
9;00 "	109	118	87	374	23	12.87	80	1030	
9;15 "	111	105	90	370	12	12.27	81	990	Turned out all but eight
9;30 "	109	101	84.5	364	6	11.01	84	925	lights in diner.
9;45 "	111	96	87	373	22	10.66	85	905	Began to turn out
10;00 "	108	90.5	93	376	18	9.78	88	860	sleeper lights.
10;20 "	108	82.5	84.5	361	10	8.91	90	800	
11;00 "	108	81.5	106	378	10	8.08	95	835	
12;00 "	108	76.5	99	378	11	8.26	97	800	
A.M. December 24, "Mountain Time."									
12;00 "	108	76.5	91	368	54	8.26	97	800	
1;00 "	111	63	84.5	371	23	6.99	110	770	

First Night West [Con.]

1;20 A.M.	116	87.5	84.5	368	15	10.15	91	925	
1;35 "	116	70	84.5	370	22	8.13	97	790	
2;10 "	116	58	86	367	17	6.74	100	674	
2;35 "	116	68	84.5	---	15	7.89	96	760	Vestibule lights on at station.
3;00 "	116	58	91	---	22	6.74	96	646	
3;30 "	117	62	84.5	371	17	7.26	101	734	
4;00 "	117	61	84.5	369	15	7.14	100	714	
4;30 "	117	60.5	106	378	18	7.08	97	686	
5;00 "	117	57	106	373	--	6.67	100	667	
5;30 "	116	61	106	372	15	7.08	91	686	
6;00 "	116	61	106	369	57	7.08	99	700	
6;30 "	116	65	106	371	7	7.54	95	715	
6;45 "	115	66	102	368	14	7.59	96	730	
7;00 "	114	77.5	99	370	—	8.84	91	805	
7;15 "	110	78.5	87	---	74	8.64	92	795	
7;30 "	106	78.5	87	---	--	8.33	93	775	
7;45 "	107	76	91	---	52	8.14	84	684	
7;52 "	104								Shut down.

Separator water 640#. Changed engine four times. Total separator water 640# +80# = 720#. Total separator water per hour = 44#.

Total oil used:

Cylinder, 3/4 pint.

Side bearings, 2 quarts.

Crank case, 3 quarts.

Second Night West, December 24 - 25, 1905.

Time.		Volts.	Amp.	Steam Press.	R.P.M.	Sep. water.	Load in K.W.	Steam Cons. /KW.hr.	Total Steam Cons. per hr.	Remarks.
		December 24, "Mountain Time."								
4;30	P.M.	108	99	87	----	12	10.7	85	910	
5;00	"	107	101	87	----	--	10.8	84.5	913	
5;30	"	108	113	99	367	15	12.21	79	965	
6;00	"	108	114	99	----	13	12.32	78.5	965	
6;30	"	109	114	103	----	--	12.42	77.5	962	
7;00	"	109	114	104	----	16	12.42	77	955	
7;50	"	108	114	96	----	--	12.32	79	972	
8;00	"	107	115	100	----	12	12.31	78	960	
8;30	"	108	114	101	----	14	12.32	77.5	955	
9;00	"	108	99	106	----	16	10.7	77	824	Diner lights turned off.
9;30	"	106	97	99	----	18	10.28	84	966	
10;00	"	108	101	85	----	10	10.91	84.5	920	
10;30	"	108	91	85	----	--	9.84	87.5	860	Sleeper lights turned off.
11;00	"	108	82.5	85	372	18	8.92	92.5	918	
11;30	"	109	71	85	370	--	7.75	98	760	
12;00	"	108	65	87	374	--	7.05	102	716	
	A.M.	December 25, 1905.								
12;30	"	108	57	88	----	14	6.15	109	668	
1;00	"	108	55	87	----	28	5.94	110	654	
1;30	"	108	61	88	370	28	6.59	105	682	
1;45	"	108	60	88	----	--	6.48	106	686	
2;30	"	116	66	106	----	--	7.65	96	735	
3;00	"	116	67	102	----	--	7.77	95.5	740	
3;30	"	116	62	106	----	--	7.19	100	719	
4;00	"	116	56	106	----	--	6.50	106	690	
4;30	"	116	60	105	----	--	6.96	100	696	
5;00	"	115	57	102	----	--	6.56	102	670	
5;30	"	116	58	105	----	19	6.73	101	677	
6;00	"	116	58	106	----	16	6.73	101	677	

Second Night West [Con.]

6;30 A.M.	116	58	106	----	16	6.73	101	677	
7;00 "	116	76.5	102	----	--	8.88	89	790	Diner lights turned on.
7;30 "	111	84.5	106	----	--	9.6	85.5	820	
		"Pacific Time."							
7;00 "	108	91.	72	----	--	9.84	94	925	
7;30 "	106	100	85	----	17	10.6	85	900	
8;00 "	108	103	82	373	8	11.12	85	943	
8;30 "	109	105	85	----	22	11.45	82.5	940	
9;00 "	108	100	85	----	28	10.8	84.5	913	Shut down.

Separator water 340#. Changed engine four times. Total separator water 340# + 80# = 420#. Separator water per hour = 21#.

None of oil cups filled.

Third Night West, December 25 - 26, 1905.

Time.	Volts.	Amp.	Steam Press.	R.P.M.	Sep. water.	Load in K.W.	Steam Cons. /KW.hr.	Total Steam Cons. per hr.	Remarks.
December 25, 1905, "Pacific Time."									
4;15 P.M.	108	97	70	----	--	10.48	93	970	
4;30 "	108	107	70	351	18	11.57	90	1040	
5;00 "	108	117	71	360	--	12.63	87	1100	
5;30 "	106	123	60	353	22	13.05	92.5	1208	
6;00 "	109	127	65	362	5	3.85	89.5	1240	
7;15 "	109	128	38	350	25	13.96	120	1667	Governor pounding, signalled for more steam and got only 52#.
7;30 "	108	126	49	357	--	13.6	95	1290	
8;00 "	108	114	72	----	--	12.31	87	1060	
9;00 "	108	110	72	369	23	11.89	88	1046	
9;30 "	108	102	82	----	12	11.01	86	945	
10;00 "	108	88	82	---	--	9.5	91.5	870	
10;30 "	108	88.5	87	----	--	9.56	88	840	
11;00 "	107	64.5	72	----	--	6.9	107.5	744	
11;30 "	107	63	78	364	23	6.74	107.5	725	
12;00 "	108	76.5	85	----	--	8.26	96	792	
A.M. December 26.									
12;30 "	108	76.5	85	----	--	8.26	96	792	
1;00 "	108	68	82	----	[illegible]	7.35	101.5	745	
1;30 "	107	67	60	----	--	7.17	110.5	792	
2;00 "	105	67	60	----	--	7.04	111.5	785	
2;30 "	106	67	85	----	27	7.1	101.5	720	
3;00 "	106	67	78	----	46	7.1	104.5	742	
3;30 "	109	68	85	----	22	7.42	100	742	
4;00 "	116	87	78	----	18	10.1	91	920	
4;30 "	116	69	82	368	--	8.0	98	784	
5;00 "	116	62	69	----	20	7.9	102	735	
5;30 "	116	50.5	85	----	--	5.86	112	666	
6;00 "	116	57	80	366	--	6.62	112	740	
6;30 "	116	55	79	----	20	6.38	109	696	

Third night West, [Con.]

7;00 A.M.	116	55	78	----	--	6.38	109.5	700
7;30 "	115	56	82	----	--	6.44	108.5	698
8;00 "	115	55	82	----	--	6.35	109	690
8;15 "								Shut down.

Separator water 340#. Change engines three times. Total separator water 340# + 60# = 400#. Total separator water per hour = 25#.

Total oil used:

Cylinder, 1/2 pint.

Side bearings, 0

Crank case, 2 quarts.

First Night East, December 27 - 28, 1905.

Time.	Volts.	Amp.	Steam Press.	R.P.M.	Sep. water.	Load in K.W.	Steam Cons. /KW.hr.	Total Steam Cons. per hr.	Remarks.
December 27 1905, "Pacific Time."									
4;10 P.M.	106	107	83	378	—	11.32	84	950	
4;30 "	106	107	83	378	22	11.32	84	950	
4;40 "	106	107	71	——	—	11.32	90	1025	
4;50 "	105	106	85	——	—	11.12	84	935	
5;10 "	106	123	50	359	24	13.04	95	1234	
5;15 "	99	121	40	——	12	11.98	120	1440	Governor pounding.
5;45 "	108	123	72	366	—	13.29	85	1130	
6;15 "	108	122	70	371	—	13.18	86	1130	
6;30 "	109	124	70	366	22	13.53	86	1160	
7;00 "	107	124	72	366	20	13.28	85	1129	
7;30 "	115	127	77	367	—	14.60	80	1168	
8;15 "	111	131	90	368	20	14.54	75	1091	
8;30 "	108	112	96	376	24	12.1	80	968	
9;00 "	109	119	80	374	20	12.98	81.5	1058	
9;30 "	101	123	91	375	—	12.42	79.5	985	
10;15 "	108	102	87	375	24	11.02	83.5	916	
10;30 "	105	94	91	372	—	9.86	87	860	
11;25 "	109	94	96	376	26	10.37	84.5	875	
11;30 "	120	94	91	379	20	11.29	82	929	
12;00 "	116	94	92	381	24	10.9	83	905	
A.M. December 28.									
12;30 "	116	74.5	92	380	22	8.65	92.5	800	Indicator motion came loose. Shut down and took it off.
1;00 "	116	68	96	385	25	7.89	96	765	
1;30 "	114	61	96	372	23	6.95	102	709	
2;00 "	116	65	93	376	44	7.55	90	680	
2;30 "	116	66	96	381	43	7.66	79.5	746	
3;45 "	110	56	115	382	23	6.16	104	640	
4;15 "	109	56	115	——	48	6.11	104	635	
4;45 "	109	51	111	383	24	5.57	111	620	

First Night East [Con.]

5;15 A.M.	109	51	111	377	24	5.57	111	620	
5;45 "	108	68	108	365	104	7.35	97.5	715	
6;15 "	108	69	109	365	21	7.45	96.5	720	
6;40 "	108	75.5	108	374	23	8.15	92.5	755	Poor steam connection
6;50 "	108	95	109	----	--	10.25	83	850	between tender and mail.
7;00 "	108	97	106	----	23	10.48	82.5	865	Reducing valve gauge
7;15 "	109	95	105	362	23	10.36	83	860	104#; engine gauge 94#.
7;45 "	108	98	105	----	17	10.58	82	868	
7;52 "	108	98	105	370	33	10.58	82	868	Shut down.

Separator water 677#. Changed engines twice. Total separator water 677# + 40 = 717#. Total separator water per hour = 43#.

None of oil cups filled.

Second Night East, December 28 - 29, 1905.

Time.	Volts.	Amp.	Steam Press.	R.P.M.	Sep. water.	Load in K.W.	Steam Cons. /KW.hr.	Total Steam Cons. per hr.	Remarks.
December 28, "Mountain Time."									
4;15 P.M.	108	111	87		—	12.0	81.5	980	
5;30 "	109	111	93		—	12.11	80	968	
6;00 "	106	110	93		20	11.67	84	980	
6;15 "	110	126	88		24	13.86	77	1070	Mail car lights turned
									on,connector not put in
6;30 "	109	125	88		23	13.63	77.5	1055	at Spokane.
7;15 "	109	127	88		20	13.85	77	1067	Poor steam connections
8;00 "	109	129	96		23	14.08	76	1070	at both couplings.
8;30 "	108	128	93		20	13.82	76.5	1054	
9;00 "	106	107	99		23	11.34	82	925	
9;30 "	108	105	98		—	11.34	82	925	
10;00 "	110	94	99		60	10.33	84.5	870	
11;00 "	105	79.5	102		23	8.35	92	768	
11;30 "	105	79.5	102		60	8.35	92	768	
12;00 "	111	79.5	105		19	8.83	89.5	790	
December 29, 1905.									
12;30 A.M.	108	73	105		20	7.88	94.5	745	
1;00 "	109	72	105		20	7.85	94.5	742	
1;30"	108	73	102		—	7.89	94	741	
2;00 "	109	73	103		22	7.95	93.5	743	
2;30 "	108	73	103		40	7.89	94	740	
3;00 "	109	75.5	105		—	8.24	92	758	
3;30 "	108	81	102		20	8.75	91	795	
4;30 "	108	80	96		—	8.15	95.5	780	Took on sleeper
4;45 "	108	50.5	96		—	5.46	115	628	"Puyallup" at Butte.
4;55 "	116	102	91		—	11.83	82	970	
5;00 "	116	72.5	85		22	8.41	95	800	Poor steam connections
5;25 "	116	67	91		—	7.77	98	760	between mail and baggage.

Second Night East [Con.]

5;35 A.M.	116	72.5	85	—	8.41	95	800	
6;00 "	116	66	91	23	7.65	98.5	755	
6;15 "	116	65	77	23	7.54	103	777	
6;25 "	116	72.5	80	—	8.41	97	815	Diner lights turned on.
6;30 "	116	72.5	82	—	8.41	96	808	
7;00 "	116	71	93	24	8.24	95	783	
7;05 "	116	92	87	—	10.68	92.5	987	
7;15 "	116	95	86	24	11.01	84	925	
7;30 "	116	96	87	21	11.13	83.5	930	
7;45 "	116	98	82	—	11.38	85	967	
7.48 "	116	101	85	—	11.72	83.5	908	
8;05 "	109	92	91	—	10.03	87	875	
8;15 "	109	95	90	24	10;38	85	880	
8;30 "	109	97	97	15	10.58	84	887	Shut down.

Separator water 615#. Changed engines once. Total separator water 615# + 20 = 635#. Total separator water per hour = 39#.

Total oil used:

Cylinder, 1/2 pint.

Side bearings, 1/2 quart.

Crank case, 1/2 quart.

Third Night East, December 29 - 30, 1905.

Time.	Volts.	Amp.	Steam Press.	R.P.M.	Sep. Water.	Load in K.W.	Steam Cons. /KW.hr.	Total Steam Cons. per hr.	Remarks.
December 29, "Mountain Time."									
4;30 P.M.	108	141	78	----	--	15.25	79	1200	
5;00 "	108	145.5	109	----	--	15.72	69	1082	
5;30 "	109	139	110	370	19	15.15	70	1058	
6;00 "	108	138	113	----	--	14.9	70	1042	
6;30 "	108	136	113	----	--	14.7	70.5	1036	
7;00 "	108	140	96	----	21	15.12	73.5	1110	
7;30 "	108	140	96	----	40	15.12	73.5	1110	
8;00 "	108	138	91	----	--	14.9	79	1178	
8;30 "	110	122	99	----	24	13.41	76	1020	
9;00 "	108	104	106	----	20	11.22	80	896	
9;30 "	108	90	106	----	--	9.73	85	826	
10;00 "	110	84	106	----	25	9.25	87	805	
10;30 "	110	77.5	85	----	20	8.53	95	802	
11;00 "	108	55	91	----	--	5.94	111.5	663	
11;30 "	108	57	85	----	20	6.16	105.5	675	
12;00 "	104	55	91	----	60	5.72	113	647	
A.M. December 30.									
12;30 "	108	55	87	----	20	5.94	111.5	662	
1;00 "	108	57	84	----	--	6.16	109	672	
"Central Time."									
2;20 "	108	60	84	----	24	6.48	106	647	
2;40 "	116	102	119	----	24	11.83	78	923	
2;41 "	116	90	115	----	--	10.43	82.5	868	
2;43 "	116	97	115	----	--	11.23	80	895	
2;44 "	116	107	115	----	--	12.4	76.5	950	
2;45 "	116	97	115	----	--	11.23	80	895	
2;49 "	116	80	115	----	24	9.28	86.5	805	
2;50 "	116	87	115	375	--	10.1	83	840	

Third Night East [Con.]

3;00 A.M.	116	68	117	----	--	7.9	93	735	
3;15 "	116	66	117	370	24	7.65	97	742	Very bad steam connections between tender and mail.
3;23 "	116	64	116	----	23	7.42	96	712	
3.30 "	116	63	116	----	--	7.31	97	710	
3;45 "	116	62	116	----	24	7.19	98	705	
4;00 "	116	62	117	----	24	7.19	98	705	
4;15 "	116	62	116	----	--	7.19	98	705	
4;30 "	116	61	116	----	24	7.07	99	700	
4;35 "	116	60	115	----	24	6.96	101	704	
4;45 "	116	60	111	----	23	6.96	104	725	
5;00 "	116	59	115	----	23	6.85	100.5	685	Positive side of line grounded.
5;15 "	116	58	116	----	23	6.73	100.5	675	
5;30 "	116	79	116	----	23	9.15	87	795	
5;45 "	116	85	110	373	24	9.86	84	830	
6;00 "	116	85	117	----	23	9.86	84	830	
6;15 "	116	88	117	----	24	10.2	82.5	840	
7;00 "	116	107	108	----	48	12.4	77	955	
7;15 "	116	104	111	375	24	12.08	76	918	
7;30 "	116	103	108	----	24	11.93	77	915	
7;45 "	116	112	107	----	24	13.0	76.5	994	
8;00 "	116	121	105	----	24	14.05	73	1025	
8;15 "	116	119	74	----	24	13.8	84	1160	
8;25 "	108	109	115	----	23	11.79	77	830	Shut down.

Separator water 887#. Change engines three times. Total separator water 887# + 60 = 947#. Total separator water per hour = 60#.

Total oil used:

Cylinder, 1/2 pint.
Crank case, 1 pint.
Side bearings, 0.

CAR DATA

[DYNAMO CAR]

No. 241.

Mail Cars.

				Replaced.		
No.	Run.	No. Lamps.	Candle Power.	No.	C.P.	Why.
78	St. Paul to Spokane	14	16	2	16	Burned out.
		4	32			
50	Spokane to Portland and Portland to Spokane	8 4	16 32			
82	Spokane to St.Paul	14	16			
		2	32			

Baggage Car #241 "Dynamo Car".

Eleven 16 c. p. lamps. No batteries.

"Duluth" [sleeper Tacoma to Spokane]

No batteries on it.

"Puyallup" [Pullman sleeper Butte to St. Paul].

Batteries.		Time	Voltage.		Why burned.	Charge.		Time of	Voltage.	
Turned on.	Turned off.	Burning.	Before.	After.		Start.	Finish.	Charge.	Before.	After.
6;30	6;39	9'	----	102	Changed engine Glendive.					
10;4	10;16	12'	----	102	Changed engine Dickinson.	2;40	8;25	5 hr.45'	102	108

Coach No. 792 "Smoker."

Batteries.		Time	Voltage.		Why burned.	Charge.		Time of	Voltage.	
Turned on.	Turned off.	Burning.	Before.	After.	West Bound.	Start.	Finish.	charge.	Before.	After.
9;45	10;30	45'	100	100	Train shed, St. Paul.					
7;15	7;23	8'	100	100	Changed Engine, Fargo.					
12;44	12;51	7'	100	96	" Mandan,	1;10	6;45	5h.35'	96	111
6;17	6;27	10'	100	102	" Glendive,					
5;12	5;21	9'	102	101.5	" Livingston,					
9;40	9;53	13'	101.5	100	" Butte,					
1;52	2;03	11'	100	100	" Missoula,	2;15	7;20	4h.5'	100	107
7;45	7;50	5'	104	101.4	" Trout Creek,					
7;33	7;42	9'	101.4	100	" Ellensburg,					
8;10	8;20	10'	100	100	Eng. uncoupled, Thorp.	3;45	8;15	4h.30'	100	103
5;12	5;22	10'	100	100	Changed Engine, Tacoma.					

Coach No. 792 "Smoker".

Batteries. Turned on.	Turned off.	Time. Burning	Voltage. Before.	Voltage. After.	Why burned.	Charge. Start.	Charge. Finish.	Time of charge.	Voltage. Before.	Voltage. After.
					East Bound.					
				101	Leaving Portland.					
7;38	7;50	12'	101	100	Changed Eng. Tacoma	11;30	3;35	4h.55"	-100	101
2;55	3;04	9'	100	100	" Ellensburg,	4;55	8;05	3h.10'	100	101
3;42	3;50	8'	100	100	" Butte,					
6;30	6;39	9'	100	100	" Glendive,					
10;05	10;15	10'	100	100	" Dickinson,	2;40	8;25	5h.45'	99	105
3;25	3;40	15'	104	101	Train shed Mnpls.					
			101	100	" " St. Paul.					

Total number of lamps 39, 8 c. p.

" " " " on storage, 10, 8 c. p.

Day Coach No. 964.

Batteries.		Time.	Voltage.		Why burned.	Charge.		Time	Voltage.	
Turned on	Turned off	of Burning.	Before.	After.	West Bound.	Start.	Finish.	of charge.	Before.	After.
9;45	10;30	45'	99.5	99	[See "Smoker"]					
7;10	7;21	7'	98.	98.5						
12;44	12;56	10'	98.5	97.7		1;10	6;45	5h.35'	97.7	109
6;17	6;27	9'	106	99						
	Not Burned.									
9;40	9;53	11'	99	98						
1;52	2;03	5'	98	98.5		2;15	7;20	4h.55'	98	106
7;45	7;50	9'	105	100						
7;33	7;42	10'	100	100						
8;10	8;20	10'	100	99.5		3;45	8;15	4h.30'	99.5	101.5
5;12	5;22	10'	101	99.5						

Day Coach No. 964.

Batteries. Turned on.	Turned off.	Time of Burning	Voltage. Before.	Voltage. After.	Why burned.	Charge. Start.	Charge. Finish	Time of charge.	Voltage. Before.	Voltage. After.
					East Bound.					
				100						
7;38	7;50	12'	100	100	[See Smoker]	11;30	3;35	4h.15'	100	100
2;55	3;04	9'	100	99						
3;42	3;50	8'	99	99		4;55	8;05	3h.10'	99	100
6;30	6;39	9'	100	99.5						
10;05	10;15	10'	99.5	99		2;40	8;25	5h.45'	98	105
3;25	3;40	15'	103	99						
			99	99						

Total Number of Lamps, 42 - 8 c. p.

" " " " on Storage, 10 - 8 c. p.

Tourist Sleeper No. 543.

Batteries. Turned on.	Turned off.	Time of Burning	Voltage. Before.	After.	Why burned.	Charge. Start.	Finish	Time of charge.	Voltage. Before.	After.
					West Bound.					
9;45	10;35	50'	98.2	98	[See Smoker]					
7;12	7;21	9'	98	98						
12;44	12;51	7'	98	97.5		1;10	6;45	5h.35'	97.5	109
6;17	6;27	10'	108.5	99.7						
5;12	5;21	9'	99.7	98.5						
9;40	9;53	13'	98.5	98.5						
1;52	2;03	11'	98.5	98		2;15	7;20	4h.55'	98	108
7;45	7;52	7'	108	100.5						
7;33	7;42	9'	99.5	99.5						
8;10	8;21	11'	99.5	99		3;45	8;15	4h.30'	99	101
5;10	5;22	12'	100.5	99						

Tourist Sleeper No. 543.

Batteries.		Time	Voltage.		Why burned.	Charge.		Time.	Voltage.	
Turned on.	Turned off.	of Burning.	Before.	After.		Start.	Finish.	of charge.	Before.	After.
					East Bound.					
				99.5						
7;38	7;50	12'	99.5	99	[See Smoker]	11;30	3;35	4h.5'	99	101
2;55	3;04	9'	100	99						
3;42	3;50	8'	99	99		4;55	8;05	3h.10'	99	99
6;30	6;39	9'	99	98.5						
10;05	10;15	10'	98.5	98		2;40	8;25	5h.45'	98	106.5
3;25	3;40	15'	102	101						
			101	100						

Total number of lamps, 29 - 16 c. p.

" " " " on storage 11 - 16 c. p.

Diner No. 1014.

Batteries.		Time	Voltage.		Why burned.	Charge.		Time	Voltage.	
Turned on.	Turned off.	of Burning.	Before.	After.		Start.	Finish.	of charge.	Before.	After.
					West Bound.					
9;45	10;30	45'	98.5	98	[See Smoker]					
7;10	7;22	12'	98	98						
	Not Burned,					1;10	6;45	5h.35'	98	107
6;17	6;27	10'	106	103.5						
5;12	5;21	9'	103.5	100.5						
9;40	9;53	13'	100.5	100.5						
1;52	2;03	11'	100.5	100		2;15	7;20	4h.5'	100	106
7;45	7;50	5'	106	104						
7;33	7;42	9'	104	100						
8;10	8;20	10'	100	99.5						

Left at Seattle, not charged.

Diner No. 1014.

Batteries.		Time	Voltage.		Why burned.	Charge.		Time	Voltage.	
Turned on.	Turned off.	of Burning.	Before.	After.		Start.	Finish.	of charge.	Before.	After.
					East Bound.					
7;38	7;50	12'	100	100 98.5	[See Smoker]					
----	----	20'	98.5	96.5	Switched at Seattle.	11;30	3;35	4h.35'	96.5	103.5
2;55	3;04	9'	102	102	[See Smoker]					
3;42	3;50	8'	102	100		4;55	8;05	3h.10'	100	104
6;30	6;39	9'	104	103						
	Not Burned.					2;40	8;25	5h.45'	101	107
3;25	3;40	15'	104	104						
	Not Burned.									

Total number of lamps 45 - 16 c. p.

" " " " on storage 12 - 16 c. p.

Pullman Sleeper "Mondamin".

Batteries. Turned on.	Batteries. Turned off.	Time of Burning.	Voltage. Before.	Voltage. After.	Why burned.	Charge. Start.	Charge. Finish.	Time of charge.	Voltage. Before.	Voltage. After.
West Bound.										
9;45	10;40	55'	98	98	[See Smoker]					
7;10	7;22	12'	98	98						
12;42	12;51	9'	98	97.7		1;10	6;45	5h.35'	97.7	107
6;17	6;27	10'	106.5	100						
5;12	5;21	9'	100	99.5						
9;40	9;53	13'	99.5	97						
1;52	2;03	11'	97	96		2;15	7;20	4h.5'	96	106
7;45	7;50	5'	104	100						
7;33	7;42	9'	100	99						
8;10	8;20	10'	99	98.8		3;45	8;15	4h.30'	98.8	101
5;12	5;22	10'	100	100						

Pullman Sleeper "Mondamin".

Batteries. Turned on.	Batteries. Turned off.	Time of Burning.	Voltage. Before.	Voltage. After.	Why burned.	Charge. Start.	Charge. Finish.	Time of charge.	Voltage. Before.	Voltage. After.
					East Bound.					
				99						
7;38	7;50	12'	99	99	[See Smoker]					
----	----	20'	99	98.5	Switched at Seattle.	11;30	3;35	4h.55'	98.5	99
2;55	3;04	9'	99	99						
3;42	3;50	8'	99	98.5		4;55	8;05	3h.10'	98.5	100
6;30	6;34	9'	99	98.5						
10;05	10;15	10'	98.5	98.5		2;40	8;25	5h.45'	98.2	105
3;25	3;40	15'	104	100						
			100	99						

Total number of lamps, 81 - 8 c. p.

" " " " on storage, 15 - 8 c. p.

Observation Car No. 1067.

Batteries. Turned on.	Batteries. Turned off.	Time of Burning.	Voltage. Before.	Voltage. After.	Why burned.	Charge. Start.	Charge. Finish.	Time of charge.	Voltage. Before.	Voltage. After.
					West Bound.					
9;45	10;40	55'	98.5	98.3	[See Smoker]					
7;10	7;20	10'	98.3	98						
	Not Burned.					1;10	6;45	5h.35'	98	108
6;17	6;27	10'	108	98						
	Not Burned.									
9;40	9;51	11'	98	97						
1;52	2;03	11'	97	97		2;15	7;20	4h.5'	97	105
7;45	7;50	5'	103	100						
7;33	7;42	9'	100	98.5						
8;10	8;20	10'	98.5	98		3;45	8;15	4h.30'	98	100
	Not Burned.									

Observation Car No. 1067.

Batteries.		Time	Voltage		Why burned.	Charge.		Time	Voltage	
Turned on.	Turned off.	of Burning.	Before.	After.		Start.	Finish.	of charge.	Before.	After.
					East Bound.					
				100						
7;30	7;50	20'	100	98.5	[See Smoker]					
----	-----	15'	98.5	98.5		11;30	3;35	4h.55'	98.5	99.5
	Not Burned.									
	Not Burned.					4;55	8;05	3h.10'	99	99
6;29	6;40	11'	99	98.5						
10;4	10;16	12'	98.5	98		2;40	7;50	5h.	98	103
3;25	3;40	15'	98	98						
			98	97						

Total number of lamps, 22 - 16 c. p.

45 - 8 c. p.

" " " " on storage, 14.

Locomotives.

Number.	Run.	Time		Dyn. Steam Turned		Date Locomotive put on.
		Put on.	Taken off.	on	off	
	West Bound.					
226	St.Paul to Fargo,	11;18	7;15	11;10	11;20	AM. Dec. 23, "Cen.T."
				11;50	11;56	A.M.
				4;30	7;15	"
216	Fargo to Mandon,	7;18	12;45	7;19	12;44	P.M.
314	Mandon to Dickinson	12;49	4;06	12;50	4;05	A.M. " 24, "M. T."
313	Dickinson - Glendive	4;12	6;21	4;14	6;20	"
240	Glendive-Billings,	6;25	1;30	6;26	7;52	"
304	Billings -Livingston,	1;37	5;14	4;30	5;11	P.M.
300	Livingston - Butte,	5;19	9;43	5;21	9;42	"
283	Butte - Missoula,	9;50	1;52	9;52	1;52	"
307	Missoula-Trout Creek,	2;03	7;48	2;03	7;46	A.M. " 25,
309	Trout Creek-Spokane,	7;50	11;15	7;50	9;00	" "Pac.T."
311	Spokane-Ellensberg,	11;25	7;36	4;15	7;34	"
296	Ellensburg-Tacoma,	7;41	5;15	7;42	5;14	P.M.
212	Tacoma - Portland,	5;19	---	5;20	8;15	A.M. " 26,
	East Bound.					
212	Portland-Tacoma,	2;00	7;42	4;10	7;41	P.M. " 27, "Pac.T."
286	Tacoma-Ellensberg,	7;45	2;58	7;48	2;56	"
310	Ellensberg-Spokane,	3;02	----	3;03	7;52	A.M. " 28,
298	Trout Creek-Butte,	4;11	3;44	4;15	3;49	P.M. "Moun.T."
304	Butte - Billings,	4;48	-----	3;55	8;30	A.M. " 29,
28-	Billings-Glendive,	-----	6;32	4;30	6;31	"
315	Glendive-Dickinson,	6;38	10;08	6;39	10;07	P.M.
210	Dickinson-Mandan,	10;14	1;07	10;15	1;07	"
---	Mandan - Fargo,	----	----	-----	7;25	A.M. " 30, "Cen.T."

Supplies.

Lamps and Shades Furnished.

Number.	Lamp C. P.	Why.	Date.	Furnished.
1	8	Burned out.	27	792
1	16	" "	27	543
1	16	" "	25	1014
1	8	" "	25	1014
1	16	" "	27	1014
1	16	" "	28	1014
1	8	Missing.	27	Mondamin.
1	16	Burned out.	27	"
4	8	Missing.	27	Duluth.
2	"Berth"	"	27	"
4	Opal shades	"	27	"
2	Berth	"	[None in stock]	

Total 5 - 16 c.p.; 7 - 8 c.p.; 2 - "Berth"; 4 shades.

Oil used;

Cylinder, 2-1/4 pints.
Side bearings, 2-1/2 quarts.
Crank case, 1-1/2 gallons.

Yard Test. January 1 1906, Baggage Car No. 241.

					M.E.P.			Steam	Total	Electrical
Set.	Time.	Steam P.	Voltage.	R.P.M.	#I.	#II.	Lead.	used.	I H.P.	H.P.
I.	11;20	77	108.2	369	21.2	19.8	38 Amp.	0#	17.33	5.52
	11;25	73	107	370	22.	20	"	67	17.82	5.45
	11;30	71	109.5	373	22.3	19.2	"	52	17.73	5.575
	11;35	72	108.2	375	22.7	18.6	"	53	17.72	5.52
	11;40	77	111	374	22.7	19.2	"	43	17.94	5.53
	11;45	83	108.2	369	23.1	20	"	57	18.22	5.52
	11;50	80.5	107	376	23	19.7	"	48.5	18.4	5.45
II.	12;20	86	108.2	376	32	31	63	0	27.18	9.15
	12;25	79.5	103.5	374	30	29.2	"	63.5	25.38	8.25
	12;30	77	108.2	375	30	27.75	"	53	24.80	9.15
	12;35	86	108.2	376	31	31.8	"	61	27.03	9.15
	12;40	87	108.2	378	31.5	30.2	"	61	26.50	9.15
	12;45	96	108.2	375	31	30	"	58	26.20	9.15
	12;50	79.5	108.2	370	30.5	30	"	57	25.60	9.15
III.	2;55	78	108	374	34	35.4	102	0	29.85	14.78
	3;00	78	108	374	34	35	"	74	29.55	14.78
	3;05	78	108	374	33.8	33.8	"	73	29	14.78
	3;10	74	108	373	33	34	"	71	28.65	14.78
	3;15	84	108	376	34.5	35.2	"	75	30.08	14.78
IV.	3;20	85.75	106	372	38	38.6	127	0	32.68	18.02
	3;25	85.75	105	368	38	38.8	"	94	32.38	17.88
	3;30	78	108	371	37	38.2	"	89	31.95	18.36
	3;35	78	109.2	377	36.8	38.5	"	90	32.45	18.6
	3;40	85.75	108	377	39	39.6	"	86	33.95	18.36

Yard Test, January 1 1906, Baggage Car No. 241, [Con,]

V.	3;45	85.75	108	376	42.2	43.8	146.5	0	37.1	21.2
	3;50	84	108	369	42	43	"	101	36.0	21.2
	3;55	78	108	370	37.7	39.4	"	97	32.7	21.2
	4;00	Indicator Mechanism loose.						104		
	4;05	"	"	"				96		
VI.	5;00	36	108	363	22.5	20	38	0	17.66	5.5
	5;05	48.5	"	372	22.5	21.5	"	54	18.62	5.5
	5;10	57	"	378	19.5	20	"	50	17.10	5.5
	5;15	45.75	"	365	20.3	21.7	"	50	17.54	5.5
	5;20	43.75	"	364	20	21.8	"	54	17.40	5.5
VII.	5;25	55	108	373	22	25.7	63	0	20.3	9.16
	5;30	47	108	370	25	25.8	"	67	21.53	9.16
	5;35	49	107	369	28	----	"	68	------	9.05
	5;40	43.75	108	365	25.3	----	"	64	------	9.16
	5;45							66		
VIII.	6;00	48.75	108	369	25.6	----	102	0	------	14.78
	6;05	38	"	364	25.4	----	"	93	------	14.78
	6;10	41	108	365	33	----	"	89	------	14.78
	6;15	52.75	108	365	26.7	----	"	88	------	14.78
	6;20	45	108	366	24.5	----	"	90	------	14.78
		Indicator cord broken on cylinder No. II.								
IX.	6;45	55	108	368	30	34	127	0	28	18.42
	6;50	56	108	370	34	38	"	106	30.53	18.42
	6;55	49	107	365	29.5	34.2	"	113	26.63	18.25
	7;00	50	108	36.4	31	35	"	111	27.53	18.42
	7;05	51	108	365	31	35	"	108	27.62	18.42

Yard Test, &c., [Con.] (3)

X.	7;15	43.5	108	376	22.5	21.2	37	0	18.83	5.36
	7;20	33	"	372	19	18.4	"	48	15.95	"
	7;25	33	"	370	20	20	"	52	16.96	"
	7;30	34	"	367	15.3	16.6	"	54.5	13.41	"
	7;35	38	"	375	21	21.6	"		18.32	"
XI.	7;35	—	–––	–––	–––	––––	63	0	––––	–––
	7;40	33	108	366	16.6	18.9	"	73	14.8	9.15
	7;45	40	"	370	23	24.6	"	74	20.17	"
	7;50	38	"	371	24.5	23	"	68	20.19	"
	7;55	33	"	365	18.8	20	"	71	16.20	"
XII.	7;50	—	–––	–––	–––	––––	102	0	––––	–––
	8;00	49	108	370	26.6	31	"	115	24.40	17.7
	8;05	45	"	376	27	30	"	111	24.60	"
	8;10	45	"	377	25	27.5	"	115	22.69	"
	8;15	46	"	372	24.9	29	"	115	23.01	"
XIII.	8;15	—	–––	–––	–––	––––	107	0	––––	–––
	8;20	47.75	108	367	29.5	31.4	"	123	25.6	18.4
	8;25	49	"	368	–––	32	"	109	––––	"
	8;30	46.75	"	363	–––	31.4	"	137	––––	"
	8;35	46	"	362	–––	29	"	124	––––	"

Indicator cord broke on cylinder No. I.

Ward Test Results.

Set.	Duration.	Steam Process.	Volts.	Amps.	K.W.	Elec. HP.	I.H.P.	Eff.	Steam #/hr.	Steam #/KW.hr.	R.P.M.
I.	30'	76.2	108.2	38	4.11	5.55	17.9	31%	641	156	372.3
III.	20'	78.4	108	102	11.01	14.78	29.42	50%	879	79.8	374.2
	Average	77.3	Not used in plotting curves.								
II.	30'	84.44	107	63.	6.74	9.05	26.09	34.7	707	105	374.9
IV.	20'	82.65	107.2	127	13.71	18.25	32.68	56.	1077	78.5	373
V.	20'	82.58	108	146.5	15.82	21.2	35.26	60	1194	76	371.6
	Average	83.22									
VI.	20'	46.1	108	38	4.1	5.5	17.66	31.1	624	152	368.4
VII.	20'	48.68	108	63	6.8	9.14	20.91	43.7	795	116.8	369.2
VIII.	20'	45.05	108	102	11.01	14.78	Indicator cord		1080	98	365.8
IX.	20'	52.20	107.8	127	13.69	18.35	broken.				
							28.06	65.5	1314	98.3	366.4
	Average	48.0									
X.	20'	36.2	108	37	4-	5.36	16.65	32.2	618	154	372
XI.	20'	36.0	108	63	6.8	9.15	17.84	51.4	858	126	368
XII.	20'	48.75	108	102	11.7	17.7	25.3	70	1358	111.5	373.7
XIII.	20'	47.4	108	127	13.71	18.4	25.6	72	1479	107.8	365
	Average	42.1									

Westinghouse Standard Engine #4625, 8-1/2" X 8", 375 R.P.M.

" D. C. Generator #113811, 25 K.W., 125 volts.

Yard Test Results of Westinghouse Engine and Generator on

C. M. & St. P. Baggage Car #336 of the "Pioneer Limited"

Chicago, Ill., Feb. 18, 1906.

Set.	Amps.	Volts.	K.W.	E.H.P.	I.H.P.	Eff.	Steam Press.	Speed.	Steam #/KW.hr.	Steam #/E.HP.hr.	Steam #/I.HPhr.
I.	0	110	0	0	2.71	0%	115	381	0	0	172.7
II.	54	110	5.94	7.96	12.04	66.2	113.2	384	95.8	71.4	97.2
III.	99.05	109.5	10.83	14.54	18.38	79.4	113.75	382.2	67.2	50.2	39.7
IV.	152.5	110	16.8	22.50	29.32	76.8	115.5	375	55.6	41.6	30.88
V.	51	110.1	5.56	7.45	12.95	57.4	72.4	378	100.3	75	43.18
VI.	99.2	110.3	10.95	14.68	20.44	71.7	67.2	372	71.6	53.4	38.3
VII.	148.3	110.5	16.4	21.97	27.27	80.4	81.67	371	65.4	48.8	39.3

Westinghouse Standard #5032, 8-1/2" X 8", 375 R.P.M.

"   D. C. Generator, 25 K.W., 125 Volts, #250678.

ENGINE DATA.

BAGGAGE CAR, No. 237.

First Night West, December 24 - 25, 1905.

Time.	Volts.	Amp.	Steam Press.	R.P.M.	Sep. water.	Load in K.W.	Steam Cons. /KW,hr.	Total Steam Cons. per hr.	Remarks.
December 24, "Central Time."									
4;40 P.M.	110	115	58	369	--	12.6	93.7	1170	2;20 P.M. oil separator
5;10 "	111	117	63	---	--	13	91.5	1180	froze up.
5;20 "	107	115	65	---	--	12.3	92	1130	Broken 16 c.p. lamp was
5;45 "		115	64	---	--	12.3	92.5	1140	replaced in vestibule
5;58 "		105	64	---	--	12.3	91.5	1138	of No. 541.
6;20 "	104	96	78	373	--	10	94	910	
6;21 "	104	89	78	---	--	9.25	92.5	102	
6;26 "	104	97	77	---	--	10.1	92.5	904	
6;34 "	107	100	80	---	19	10.7	----	----	Put in fuse in circuit
6;35 "	107	100	82	---	--	10.7	----	----	No. 1 of No. 541.
6;37 "	107	100	83	367	--	10.7	----	----	
7;00 "	107	100	83	---	--	10.7	86	920	
7;15 "	106	104	82	---	21	11	----	----	
7;35 "	105	108	80	---	--	11.3	85.5	966	Reducing valve gauge 110#.
7;40 "	105	107	81	372	--	11.25	----	----	
7;55 "	102	108	60	---	16	10.9	----	----	
8;00 "	106	109	87	---	--	11.5	83	956	
8;35 "	102	103	84	---	--	10.5	85	890	
8;40 "	107	108	86	---	25	11.6	----	----	
8;50 "	111	91	83	358	--	10.1	----	----	
9;00 "	112	92	83	---	18	10.4	87	905	
9;15 "	109	83	81	---	4	9	----	----	
9;30 "	108	75	90	---	17	8.1	95	770	Diner lights turned out.
10;20 "	107	68	90	---	17	7.5	100	730	
10;40 "	105	66	93	---	17	6.95	----	----	
10;45 "	---	65	100	380	14	6.9	----	----	
10;55 "	107	64	90	---	18	6.85	----	----	
11;05 "	105	63	88	---	14	6.6	105	690	

First Night West,[Con.]

11;25 P.M.	105	62	88	----	18	6.2	----	----	
11;35 "	105	59	88	----	19	5.1	121	620	
11;45 "	105	48	88	----	17	5.8	----	----	Storage has been on in
December 25, 1905.									#966 with generator and
12;03 A.M.	105	55	90	376	15	5.5	112	615	light circuit since Fargo.
12;13 "	103	53	93	----	--	5.7	----	----	
12;30 "	106	62	85	----	--	6.5	106	640	
December 24, "Mountain Time."									
11;40 P.M.	109	45	80	369	19	4.9	----	----	
11;50 "	109	45	86	----	--	4.9	126	620	
December 25, 1905.									
12;05 A.M.	109	45	83	----	10	4.9	----	----	
12;15 "	110	52	81	----	--	5.6	114	670	
12;25 "	113	52	82	375	--	5.9	----	----	Poor steam connections
12;50 "	113	53	83	----	19	6.0	112	690	between engine and bagg.
1;00 "	112	55	82	367	--	6.15	----	----	because coupling would
1;10 "	115	53	82	----	16	6.1	----	----	not fit.
1;20 "	115	50	80	----	--	5.75	140	460	
1;28 "	115	32	80	372	--	3.7	----	----	
1;35 "	108	34	80	----	15	3.68	140	450	
1;55 "	107	34	82	382	16	3.68	140	450	Reducing valve gauge 87#.
2;25 "	107	34	83	380	18	3.68	----	----	
2;40 "	107	34	83	----	18	3.68	----	----	
2;45 "	107	34	80	358	16	3.3	154	510	
2;52 "	107	34	80	----	15	3.28	154	505	Fuse was blown in No.
3;25 "	107	31	81	373	16	3.28	----	----	795 because brakeman
3;45 "	106	31	82	----	18	3.3	154	510	threw charging switch.
4;30 "	106	32	80	373	16	3.4	152	520	
5;30 "	106	32	80	----	17	4	139	555	
6;00 "	105	38	81	----	17	4.45	----	----	
6;10 "	104	43	82	----	18	5.2	----	----	
6;25 "	104	50	81	368	18	5.8	112	650	
6;30 "	104	56	80	----	17	5.9	----	----	
6;35 "	105	56	85	----	--	6.5	----	----	

First Night West [Concluded.]

6;40 A.M.	106	62	78	---	--	6.8	106	720	
7;00 "	106	64	78	---	13	6.7	----	----	
7;20 "	107	64	77	369	18	6.85	----	----	
7;35 "	108	66	79	---	7	7.1	104	732	
7;40 "									Shut down.

Total separator water 586#. Total separator water per hour 36#.

Second Night West, December 25 - 26, 1905.

December 25, 1905, "Mountain Time."

Time.		Volts.	Amp.	Steam Press.	R.P.M.	Sep. water.	Load in K.W.	Steam Cons. /KW.hr.	Total Steam Cons. per hr.	Remarks.
4;20	P.M.	108	78	102	---	--	8.3	94.5	785	Connections not good
4;35	"	107	97	98	372	16	10.5	----	----	between tender and
4;45	"	105	97	99	---	--	10.15	----	----	mail.
4;48	"	105	108	95	---	--	11.3	----	----	Lamp in vestibule of
4;59	"	107	111	91	---	--	11.9	----	----	No.541 does not go
5;05	"	107	111	98	---	19	11.9	80	952	out on closing door.
5;10	"	110	115	98	383	--	12.65	----	----	
5;15	"	108	111	102	---	18	12	----	----	
5;18	"	107	111	100	378	--	11.9	----	----	
5.25	"	107	111	100	---	--	11.9	----	----	
5;35	"	107	111	100	---	--	11.9	79	940	
5;40	"	107	111	100	369	16	11.9	----	----	
5;55	"	107	115	97	362	--	12.3	----	----	
6;05	"	110	115	94	---	--	12.65	79	1000	
6;15	"	110	111	100	---	--	12.1	----	----	
6;30	"	109	114	76	378	--	12.4	85.5	1060	
6;35	"	110	114	82	---	15	12.6	----	----	
6;40	"	110	115	101	372	17	12.65	----	----	
6;50	"	109	112	100	---	--	12.2	----	----	
7;00	"	109	111	90	---	20	12.1	81	980	Bad connection between
7;10	"	110	111	93	---	--	12.1	----	----	tender and mail.
7;15	"	110	108	87	---	20	11.9	----	----	
7;30	"	111	108	101	379	--	12.0	78.5	940	
7;40	"	106	114	95	---	19	12.1	----	----	
7.50	"	106	109	112	---	--	11.6	----	----	
7;55	"	109	110	110	---	18	12	----	----	
8;05	"	108	111	102	377	19	12	78.5	940	
8;20	"	105	105	103	---	12	11	----	----	
8;40	"	105	105	95	---	14	10.7	84	900	
8;45	"	104	103	90	---	12	10.3	----	----	

Second Night West [Con.]

8;50 P.M.	104	90	87	372	20	9.35	----	----	
9;00 "	105	95	83	---	--	9.98	88.5	880	
9;30 "	107	91	83	---	--	10.1	88.5	895	
9;55 "	109	78	72	378	13	8.5	100	850	
10;10 "	107	74	75	---	15	86	102.5	770	
10;20 "	107	70	78	---	18	7.5	----	----	
10;25 "	110	70	77	377	19	7.5	----	----	
10;40 "	107	70	77	---	16	7.5	----	----	
10;50 "	107	63	77	---	20	6.9	127	650	
11;08 "	108	49	79	377	17	5.12	----	----	
11;21 "	109	47	78	---	--	5.0	127	650	8 c.p. lamp burned out and replaced in No.795.
11;40 "	107	47	80	---	--	5.1	127	650	
12;00 "	108	47	80	378	16	5.12	129	650	
December 26, 1905.									
12;25 A.M.	107	47	78	---	17.5	5.0	----	----	
1;30 "	Engine shut down to 2;05 to put new steam coupling on mail car.								
2;20 "	111	52	79	---	19	5.76	----	----	Porter cuts in an electric flatiron taking 6 amperes at 110 volts.
2;22 "	120	100	80	---	--	12	----	----	
2;23 "	120	90	80	366	--	10.8	92	994	
2;55 "	114	58	77	---	14	6.6	108	714	One lamp burned out and replaced in No.541.
3;20 "	115	55	80	---	17	6.2	----	----	
3;30 "	116	50	79	---	18	6.8	106	720	
3;50 "	114	47	78	367	17	5.35	120	644	
4;20 "	114	47	80	---	--	5.37	119	640	
"Pacific Time."									
5;30 "	113	45	80	---	14	5.1	121	615	
6;10 "	110	35	80	---	--	3.86	154	575	Car No.795 without light from 6;50 to 7;00 because No.1switch was not closed.
7;00 "	108	55	60	365	--	5.9	120	710	
7;15 "	108	57	54	---	17	6.15	----	----	Very bad leak between engine and tender.
7;26 "	108	56	58	---	16	6.05	119	720	
7;45 "	111	62	52	368	16	6.9	----	----	

Second Night West, [Concluded.]

7;55 A.M.	109	67	56	----	5	7.3	------	-----	Boiler pressure 180#
8;00 "	107	74	51	----	16	8.0	108.5	870	reducing valve guage
8;30 "	110	87	54	369	---	9.6	102	980	95#.
8;45 "									Shut down.

Total separator water 592#. Total separator water per hour 37#.

Third Night West, December 26 - 27, 1905.

Time.	Volts.	Amp.	Steam Press.	R.P.M.	Sep. water.	Load in K.W.	Steam Cons. /KW.hr.	Total Steam Cons. per hr.	Remarks.
December 26, "Pacific Time."									
4;12 P.M.	107	92	56	355	14	9.8	101	990	
4;30 "	103	100	54	363	--	10.3	100.5	1030	
4;45 "	105	105	48	360	12	11	----	----	
5;00 "	105	105	48	365	--	11.0	99.5	1095	
5;12 "	107	110	53	373	14	11.8	----	----	
5;23 "	107	109	54	365	--	11.7	97	1135	
5;48 "	105	108	53	363	--	11.35	----	----	
6;05 "	106	107	51	360	18	11.3	98	1105	
6;15 "	105	107	50	361	--	11.25	----	----	
6.30 "	107	107	49	359	--	11.45	98-	1130	
7;00 "	104	100	60	369	15	10.4	98.5	1025	
7;30 "	110	107	70	360	--	11.8	89	1050	
7;40 "	104	101	77	358	15	10.5	----	----	
8;00 "	107	103	65	370	--	11	95	1045	
8;30 "	106	108	82	365	20	11.45	84.5	970	
9;00 "	104	106	60	368	--	11	96.5	1060	
9;13 "	107	92	58	---	20	9.85	-----	----	Bad steam connection between tender and mail.
9;24 "	108	75	85	---	20	8.1	-----	----	
9;30 "	106	71	70	363	--	7.95	102.5	815	
9;45 "	104	69	68	---	20	7.2	----	----	
10;00 "	104	69	67	370	16	7.2	108.5	785	
10;15 "	104	65	67	360	--	6.75	----	----	
10;20 "	102	62	61	---	16	6.3	----	----	
10;25 "	100	60	57	---	--	6.0	----	----	
10;30 "	105	64	67	---	16	6.7	117	745	
10;45 "	107	63	63	367	--	6.75	----	----	
11;00 "	105	64	62	---	18	6.7	112.5	754	

Third Night West, [Con.]

11;20	P.M.	103	65	65	378	--	6.7	----	----	
11;40	"	108	70	70	----	20	7.6	104	790	
12;00	"	107	68	80	----	18	7.35	102.5	750	
December 27, 1905.										
12;15	A.M.	106	68	80	----	16	7.2	----	----	
12;23	"	104	35	80	----	15	3.65	151	570	
12;55	"	109	73	75	----	--	8.0	102	816	
1;15	"	107	82	80	----	--	8.8	95	835	
1;20	"	106	77	75	----	18	8.15	----	----	
1;30	"	107	66	85	----	13	7.1	102	725	
1;45	"	106	61	80	385	16	6.5	----	----	
2;00	"	105	62	86	----	19	6.5	106	690	
2;10	"	105	60	90	----	14	6.3	----	----	
2;30	"	107	45	70	----	13	4.8	134	645	
2;45	"	107	45	70	362	14	4.8	----	----	
3;30	"	107	60	65	369	13	6.4	114	730	Bad connection between engine and tender and not good between tender and mail.
4;00	"	106	53	67	----	15	5.6	121	680	
4;15	"	106	55	60	372	17	5.8	----	----	
4;30	"	103	49	58	369	14	5.1	127	650	
5;00	"	107	52	72	----	16	5.6	118	660	
5;35	"	102	47	60	368	17	4.8	136	655	
6;00	"	105	51	65	----	16	5.35	123	660	
6;20	"	105	51	65	----	17	5.35	----	----	
6;30	"	105	51	58	372	14	5.35	132	710	
7;30	"	107	20	80	----	20	2.12	156	320	Shut down to cross river on ferry.
7;40	"	105	48	70	367	20	5.0	----	----	
7;45	"	106	67	68	----	17	7.1	----	----	
8;00	"									Shut down.

Total separator water 623#. Total separator water per hour 39#.

First Night East, December 28 - 29, 1905.

Time.		Volts.	Amp.	Steam Press.	R.P.M.	Sep. water.	Load in K.W.	Steam Cons. /KW.hr.	Total Steam Cons. per hr.	Remarks.
		December 28, "Pacific Time."								
4;00	P.M.	107.5	107	95	373	18	11.5	81.5	940	
4;30	"	107	110	93	----	15	11.8	81	955	
5;00	"	106	110	90	371	40	11.7	82	960	
5;30	"	106	110	95	366	17	11.7	82	960	
6;00	"	106.5	112	98	374	14	12.7	78.5	1000	
6;30	"	107	113	98	376	36	13.0	77.5	1010	Bad connection between
7;00	"	106	111	95	375	20	11.65	80.5	940	baggage and mail.
7;30	"	109	103	70	368	20	10.6	83.5	885	
8;00	"	108	115	70	367	35	12.4	87.5	1085	
8;30	"	106	121	72	366	28	12.8	87	1100	
9;00	"	108	109	72	375	20	11.8	88.5	1040	
9;30	"	108	98	75	369	30	11.55	88.9	1025	
10;00	"	106	90	70	370	48	10.3	98.5	1020	
10;30	"	107	95	75	368	40	10.2	99.4	1012	
11;00	"	107	98	73	370	19	10.5	91.5	960	
11;30	"	109	93	75	371	14	10.1	95.4	963	
12;00	"	108	71	77	372	39	7.67	102.5	787	
		December 29, 1905.								
12;30	"	108	71	75	374	36	7.67	103	787	
1;00	"	107	70	75	376	41	7.49	103.5	875	
1;30	"	115	70	75	376	36	8.05	101	815	
2;00	"	115	82	75	375	40	9.4	94	885	
2;30	"	115	70	75	----	17	8.05	101	815	
3;00	"	115	60	60	366	16	6.9	106	730	
3;30	"	106	57	60	----	27	6.0	118	710	
4;00	"	107	38	60	361	36	4.06	142	580	

First Night East, [Con.]

4;30 P.M.	107	44	57	360	31	4.7	135	635	
5;00 "	108	45	57	362	33	4.85	132	640	
5;30 "	107	46	55	360	19	4.9	132	648	
6;00 "	108	52	55	364	18	5.6	123	690	
6;30 "	107	66	54	362	19	7.05	111.5	790	
7;00 "	107	75	55	360	20	10.9	99.5	1084	
7;30 "	107	75	52	358	36	10.9	101	1100	
8;00 "									Shut down.

Total separator water 934#. Total separator water per hour 60#.

Second Night East, December 29 - 30, 1905.

Time.	Volts.	Amp.	Steam Press.	R.P.M.	Sep. water.	Load in K.W.	Steam Cons. /KW.hr.	Total Steam Cons. per hr.	Remarks.
December 29, "Pacific Time."									
4;00 P.M.	108	88	60	368	21	9.5	101.5	965	
4;30 "	106.5	109	60	364	21	11.6	95	1100	
5;00 "	106.5	110	55	374	37	11.7	96.5	1130	
5;30 "	105.5	119	62	364	16	12.6	92	1160	Very bad steam connection between locomotive and tender.
6;00 "	105	107	78	369	26	11.2	87	975	
6;30 "	106	109	75	370	19	11.55	88	1020	
7;00 "	106	110	75	----	19	11.65	87.5	1020	
7;30 "	106	112	75	367	19	11.9	86.5	1030	
8;00 "	108	111	75	373	42	12.0	86	1033	
8;30 "	107	110	78	373	18-	11.8	85	1000	
9;00 "	106.5	85	78	----	37	9.05	95	860	
9;30 "	107	78	78	----	34	8.35	97.5	817	
10;00 "	107	77	78	368	14	8.25	98.5	813	
10;30 "	107	68	70	----	15	7.3	106	775	
"Mountain Time."									
12;00 "	107	67	70	365	32	6.2	107	765	
December 30, 1905.									
12;30 A.M.	115	54	70	366	14	6.2	113	700	
1;00 "	115	54	70	364	14	6.1	113	700	
1;30 "	115	53	70	367	14	6.0	114	695	
2;00 "	115	52	72	369	10	4.3	114	684	
2;30 "	107	40	74	370	15	4.85	145	625	
3;00 "	108	45	73	366	21	4.9	135	655	
3;30 "	109	45	72	375	42	4.55	137	661	
4;00 "	106	43	73	----	18	5.1	140	637	
4;30 "	106	48	83	370	31	5.6	124	633	
5;00 "	106	53	81	366	17	6.1	118	662	

Second Night East, [Con.]

5;30 A.M.	106	57	82	368	17	6.6	110	671	
6;00 "	110	60	80	369	19	7.35	107	706	
6;30 "	108	68	80	369	19	7.5	103	756	
7;00 "	110	68	80	368	15	7.56	101.5	762	
7;30 "	109	95	80	367	40	10.6	88	933	
8;00 "									Shut down.

Total separator water 666#. Total separator water per hour 44#.

Third Night East, December 30 - 31, 1905.

Time.		Volts.	Amp.	Steam Press.	R.P.M.	Sep. water.	Load in K.W.	Steam Cons. /KW.hr.	Total Steam Cons. per hr.	Remarks.
December 30 "Mountain Time."										
4;30	P.M.	107	110	55	364	21	11.8	96	1132	
4;45	"	107	130	55	358	35	13.9	92.5	1285	
5;00	"	107.5	132	55	369	16	14.2	92	1305	
5;30	"	108	128	57	365	20	13.8	92	1270	Steam connection was repaired at Billings.
6;00	"	108	117	85	368	18	12.6	80	1007	
6;30	"	108	132	80	371	16	14.2	79	1120	
7;00	"	108	132	80	374	20	14.2	79	1120	
7;30	"	106.5	123	80	376	22	13.1	81	1060	
8;00	"	107	120	80	372	14	12.8	81.5	1042	
8;30	"	107	120	80	----	19	12.8	81.5	1042	
9;00	"	107	113	80	375	16	12.1	83	1005	Bad connection between engine and mail.
9;30	"	107	98	83	361	15	10.5	86.5	910	
10;00	"	107	87	82	371	16	9.3	92.5	860	
10;30	"	107	85	80	376	17	9.1	94	855	
11;00	"	107	81	80	374	21	8.65	91.5	825	
11;30	"	107	71	81	376	18	7.6	101	768	
12;00	"	108	65	85	376	24	7.0	102.5	718	
December 31, 1905.										
12;30	A.M.	107	60	85	375	96	6.4	107	685	
1;00	"	107	55	85	372	22	5.9	111	655	
"Central Time."										
2;30	"	107	54	75	369	21	5.8	112	650	
3;00	"	118	87	70	372	21	10.3	93.5	964	
3;30	"	115	75	77	373	22	8.65	97	840	
4;00	"	116	62	75	375	21	7.2	113	742	

Third Night East, [Con.]

5;00 A.M.	106	50	75	370 25	5.3	122	642	
5;30 "	106	50	77	369 17	5.3	121	794	
6;00 "	105	52	73	373 25	5.5	120	1040	
6;30 "	106	73	60	372 42	7.74	102.5	956	
7;00 "	107	99	73	367 22	10.6	98	964	
7;30 "	109	96	76	370 25	10.55	93	984	
8;00 "	109	97	80	371 25	9.16	91	862	
8;30 "								Shut down.

Total separator water 731#. Total separator water per hour 31#.

CAR DATA.

BAGGAGE CAR, No. 237.

Mail Car No. 51.

Number of Lamps,

8 - 16 c. p.

4 - 32 c. p.

No Storage.

Baggage Car No. 237.

Number of Lamps.

9 - 16 c. p.

2 - 8 c. p.

No Storage.

"Red Lodge."

Taken from Portland to Spokane.

Number of Lamps, 28 - 8 c. p.

No Storage.

"Dacota" [Pullman Sleeper, Butte - St. Paul]

Batteries.		Voltage.	
Turned on.	Turned off.	Before,	After.
5;50	6;00	101	101

Car No. 795. "Smoker."

Batteries. Turned on.	Turned off.	Voltage. Before.	After.	Time Burning.	Why burning.	Charge. Time. Start.	Finish	During.	Voltage. Before.	After.
					Going West.					
9;30	10;15	101	100	45'	St.Paul train shed.	11;40	1;28	1h.48"	100	102
10;40	10;45	100	100	5	Mnpls. " "					
5;58	6;10	100	100	12	Change Eng at Fargo.					
12;17	12;31	101	100	14	" " at Mandan.					
2;55	3;08	104	103	13	" " " Dickinson					
6;15	6;25	102	101	10	" Glendive,	2;20	5;50	3h.30"	100	107
9;04	9;13	101	100	9	" Butte.					
6;43	6;55	107	102	10	" Ellensburg.					
2;45	2;58	102	101	13	" Tacoma,					

Car No. 795, "Smoker."

Batteries.						Charge.				
Turned on.	Turned off.	Voltage. Before.	Voltage. After.	Time Burning.	Why burning.	Time. Start.	Time. Finish.	Time. During.	Voltage. Before.	Voltage. After.
				Going East.						
2;00	2;15	101	101	15'	Train Shed, Port.					
7;15	7;28	101	100	13	Changed Eng. at Tacoma,	1;00	3;00	2'00"	100	103
3;35	3;45	103	102	10	Changed Ellensburg.					
6;05	6;15	102.2	101	10	" Trout Creek,					
11;15	10;25	101	101	10	" Missoula					
4;22	4;30	101	100	8	" Butte,	12;30	2;00	1'30"	100	103
5;50	6;00	103	103	10	" Glendive.					
9;50	10;05	103	101	15	" Dickinson.					
2;15	2;25	101	100	10	" Mandan,	3;00	4;30	1'30"	100	103

No of Lamps = 38 - 8 c.p.

No on storage = 10 - 8 c.p.

Car No. 966, Coach.

Batteries.						Charge.				
Turned on.	Turned off.	Voltage. Before	Voltage. After.	Time Burning.	Why burning.	Time Start.	Finish	During	Voltage. Before.	Voltage. After.
				Going West.						
9;30	10;15	101	100	45'	[Same as Car 795]	11;40	1;28	1'48"	98	102
10;40	10;45	100	99	5						
5;58	6;10	99	99	12						
12;17	12;31	49	98	14						
2;55	3;08	102	101	13						
6;15	6;25	100	101	10		2;20	5;50	3'30"	100	101
9;04	9;13	101	100	9						
6;43	6;53	100	101	10						
2;45	2;58	101	100	13						
				Going East.						
2;00	2;15	100	100	15	[Same as Car 795]					
7;15	7;28	100	100	13						
3;35	3;45	103	102	10		1;00	3;00	2'00"	100	103
6;05	6;15	101.2	101	10						
10;15	10;25	101	100.5	10						
4;22	4;30	100.5	100	8		12;30	2;00	1'30"	100	101
5;50	6;00	103	102	10						
9;50	10;05	102	101	15						
2;15	2;25	101	100	10		3;00	4;30	1'30"	100	103

No of Lamps = 42 - 8 c.p.

No on Storage = 11 - 8 c.p.

Car No. 541, Tourist Sleeper.

Batteries.						Charge.				
Turned on	Turned off	Time Burning	Voltage. Before	Voltage. After	Why burning.	Time start.	Finish	During	Voltage. Before	Voltage. After
					Going West.					
9;30	10;15	45'	101	101	[Same as Car 795]					
10;40	10;45	5	104	100		11;40	1;28	1'48"	99	101
5;58	6;10	12	100	100						
12;17	12;31	14	100	99						
2;55	3;08	13	101	100		2;20	5;50	3'30"	99	105
6;15	6;25	10	100	100						
9;04	9;23	19	100	99						
6;43	6;53	10	105	103						
2;45	2;58	13	103	101						
					Going East.					
2;00	2;15	15	101	100	[Same as Car 795]					
7;15	7;28	13	100	99		1;00	3;00	2"00	99	105
Storage not used.										
6;05	6;15	10	102	101						
10;15	10;25	10	101	101		12;30	2;00	1'30"	100	103
4;22	4;30	8	101	100						
5;50	6;00	10	100	100						
9;50	10;05	15	103	101.5						
2;15	2;25	10	101.5	100		3;00	4;30	1'30"	101	103

No of lamps, 24 - 16 c.p.
12 - 8 c. p.
No on storage = 11

Diner Car No. 1031.

Batteries.						Charge.				
Turned on.	Turned off.	Time Burning.	Voltage Before.	Voltage After.	Why burned.	Time Start,	Finish	During	Voltage. Before.	After
				Going West.						
9;30	10;15	45'	101	100	[See Car 795]					
10;40	10;45	5	100	100		11;40	1;28	1'48"	99	103
5;58	6;10	12	100	99						
12;17	12;31	14	99	89						
2;55	3;08	13	102	101						
6;15	6;25	10	101	100		2;20	5;50	3'30"	100	105
9;04	9;13	9	100	100						
6;43	6;53	10	105	103						
2;45	2;58	13	103	102						
				Going East.						
2;00	2;15	15	102	101						
7;15	7;28	13	101	100		1;00	3;00	2'00"	100	106
	Storage not used									
6;05	6;15	10	103	101						
10;15	10;25	10	101	101						
4;22	4;30	8	101	100		12;30	2;00	1'30"	101	106
5;50	6;00	10	105	103						
9;50	10;05	15	103	102.5						
2;15	2;25	10	102.5	101		3;00	4;30	1'30"	101	105

No of lamps = 48 - 16 c.p.
No on storage = 13.

"Kooskia" [Pullman Sleeper].

Batteries.						Charge.				
Turned on	Turned off	Time Burning.	Voltage Before.	Voltage After.	Why burned.	Time. Start.	Time. Finish.	During.	Voltage. Before	Voltage. After.
					Going West.					
9;30	10;15	45'	95	94	[Same as Car 795].					
10;40	10;45	5	94	93		11;40	1;28	1'48"	83	101
5;58	6;10	12	93	93						
12;17	12;31	14	93	83						
2;55	3;08	13	101	100						
6;15	6;25	10	100	99		2;20	5;50	3'30"	98	102
9;04	9;13	9	99	98						
6;43	6;53	10	102	101						
2;45	2;58	13	101	89						
					Going East.					
2;00	2;15	15'	89	80						
7;15	7;28	13	80	80						
Storage not used.						1;00	3;00	2'00"	80	101
6;05	6;15	10	96	94.5						
10;15	10;25	10	94.5	94						
4;22	4;30	8	101	100						
5;50	6;00	10	100	96		12;30	2;00	1'30"	94	101
9;50	10;05	15	102	99						
2;15	2;25	10	99	98		3;00	4;30	1'30"	96	102

No of Lamps = 79 - 8 c.p.

No on storage - 17.

Observation Car.

Batteries.						Charge.				
Turned on	Turned off	Time Burning.	Voltage. Before.	Voltage. After.	Why burned.	Time. Start.	Time. Finish	Time. During.	Voltage. Before.	Voltage. After.
					Going West.					
9;30	10;15	45'	99	98	[Same as Car 795]	11;40	1;28	1'48"	96	102
10;40	10;45	5	98	98						
5;58	6;10	12	98	97						
12;17	12;31	14	97	96						
2;55	3;08	13	102	101						
6;15	6;25	10	101	99		2;20	5;50	3'30"	99	104
9;04	9;13	9	104	103						
6;43	6;53	10	102	101						
2;45	2;58	13	101	101						
					Going East.					
2;00	2;15	15'	101	101						
7;15	7;28	13	101	99		1;00	3;00	2'00"	98	101
	Storage not used.									
6;05	6;15	10	101	101						
10;15	10;25	10	101	99		12;30	2;00	1'30"	99	102
4;22	4;30	8	102	101						
5;50	6;00	10	101	100						
9;50	10;05	15	103	102						
2;15	2;25	10	101.5	101		3;00	4;30	1'30"	100	103

No of lamps, 22 - 16 c.p.
45 - 8 c.p.

No of lamps on storage -- 14.

Battery Input & Open Circuit Discharge.

Amperes. Input. During.					Charge. Second Night East.	
			Car No.			
Time.	795	966	541	1031	"Kooskia"	Observation.
12;45	2.5	4.5	4.5	2.	6	5.5
1;00	2.5	3.5	3.5	2.	3.5	2.5
1;30	1.5	2.5	2.5	2.	3.5	2.5
2;15	1.5	2.5	1.5	2.	2.5	2.5

Battery. Voltages. Eff.			Standing on open circuit December 30.			
10;30	103	101.5	101.2	102.5	99	101.5
11;30	102.8	102.8	101	101.2	99	101.3
12;30	102.2	101	101	102.5	99	101.2
1;30	102	101	101	102	98.8	101
2;30	102	101	101	102	98.8	101.8
3;30	102	102	101	101	98.5	100.8
5;00	101.5	100.8	101	101.5	98.1	100.7

LOCOMOTIVES.

No.	Pres.	Division	Time on.	Time off.
		Going West.		
216	200	St. Paul to Fargo.	9;30	5;58
217	200	Fargo to Mandan,	6;10	12;17
316	200	Mandan - Dickenson,	12;31	2;55
317	"	Dickenson - Glendive,	3;05	6;15
241	"	Glendive - Billings,	6;25	12;45
301	"	Billings - Butte,	12;50	9;04
298	"	Butte - Missoula	9;13	1;30
280	"	Missoula - Trout Creek,	1;35	4;35
---	"	Trout Creek - Spokane,	4;40	11;15
307	"	Spokane - Ellensburg,	11;20	6;43
292	"	Ellensburg - Tacoma,	6;53	2;20
212	"	Tacoma - Portland,	2;25	8;40
	"	Going East.		
212	"	Portland - Tacoma,	2;00	7;15
287	"	Tacoma - Ellensburg,	7;28	3;35
307	"	Ellensburg - Spokane,	3;45	11;55
304	"	Spokane - Trout Creek,	12;00	6;00
299	"	Trout Creek - Butte,	6;05	4;23
300		Butte - Billings,	4;30	11;40
944		Billings - Dickinson,	11;45	3;35
313		Dickinson - Mandan,	10;05	2;15
317		Mandan - Fargo,	2;25	9;15
216		Fargo - St. Paul,	9;20	4;20

Steam Consumption Per Night.

Night.	K.W.Hrs. Load.	Total Steam. Cons.	Number hours run.	Arc Load in K.W.	Steam Cons. #/K.W.	Arc St. # per K.W.hr.	Sep. Water #	Total Steam From Locomotive in gallons.
				Car No. 241.				
1 West.	149.85	15930	16.25	9.22	980	106.4	720	2000
2 "	161.5	15750	17.5	9.24	900	97.5	420	1940
3 "	144.1	15740	15.75	9.16	1000	109.2	400	1940
1 East	156.5	15860	15.75	9.25	1005	101.	717	1990
2 "	154.1	11480	15.75	9.7	730	75.4	635	1460
3 "	159	15030	15.0	10.6	1002	94.7	947	1920
Total,	925.05	89790	96.	9.65	937	97.3	3839	11250
				Car No. 237.				
1 West	109.7	10530	16.0	6.87	660	96	586	1340
2 "	121.4	13750	16.0	7.59	860	113	592	1730
3 "	120.4	15810	15.75	7.65	1003	131.2	623	1980
1 East	145.2	16300	16.25	8.95	1002	112.2	934	2080
2 "	119.4	13775	14.5	8.24	950	115.4	666	1740
3 "	144.2	15460	15.0	9.63	1030	107.3	731	1950
Total,	760.3	85625	93.5	8.17	918	112.	4132	10820

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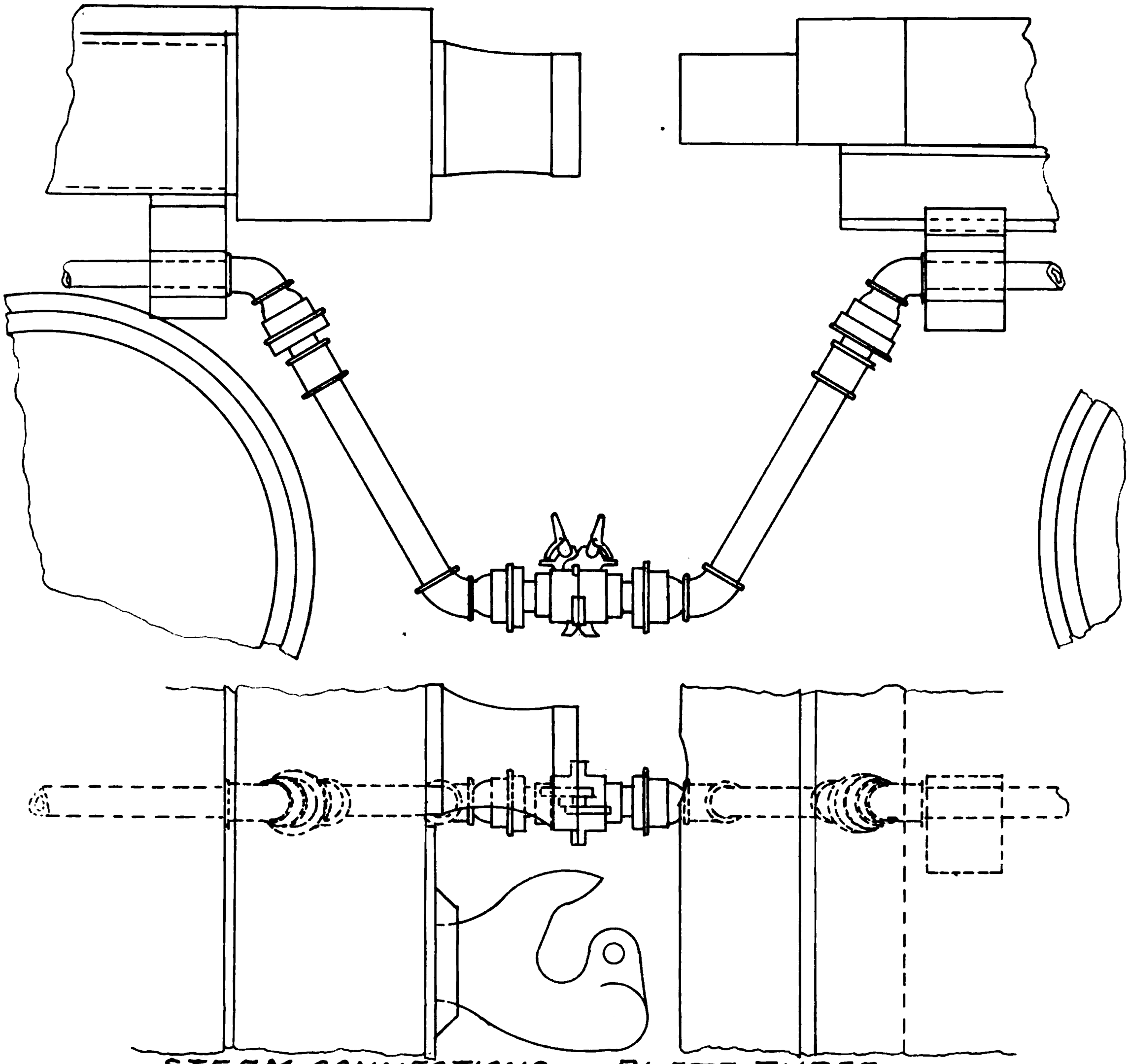
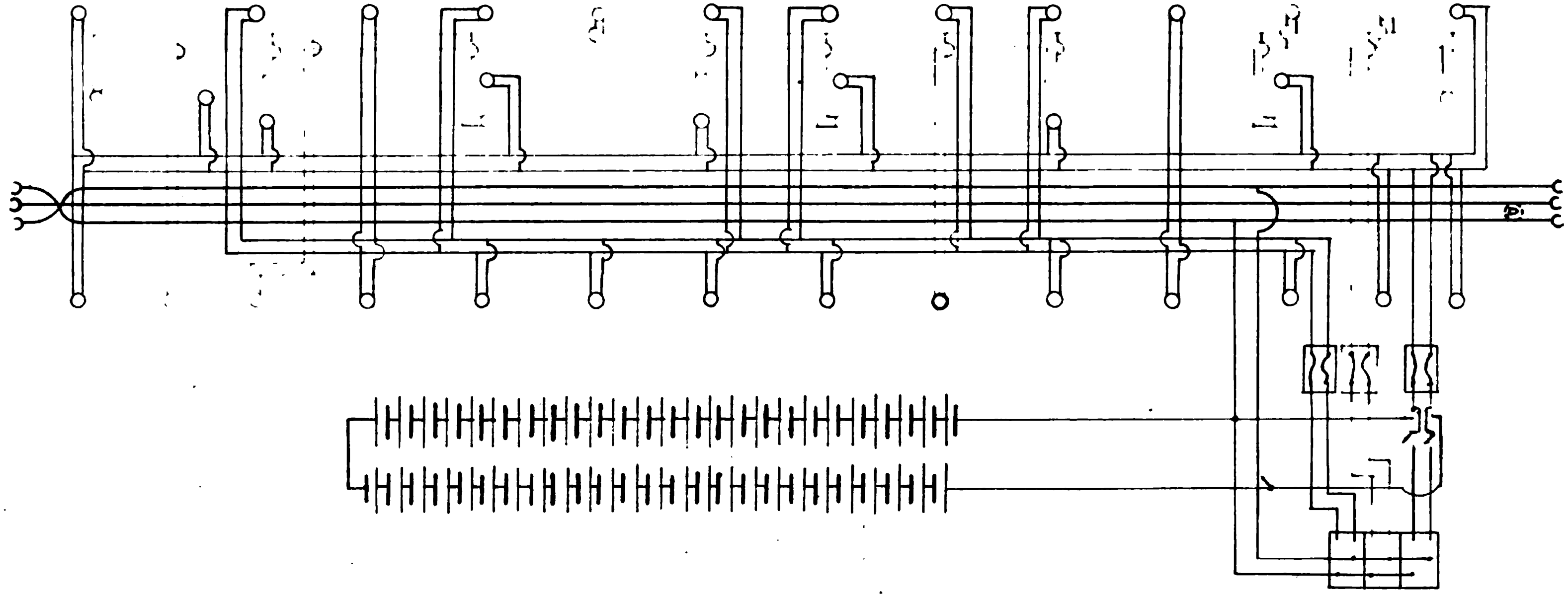
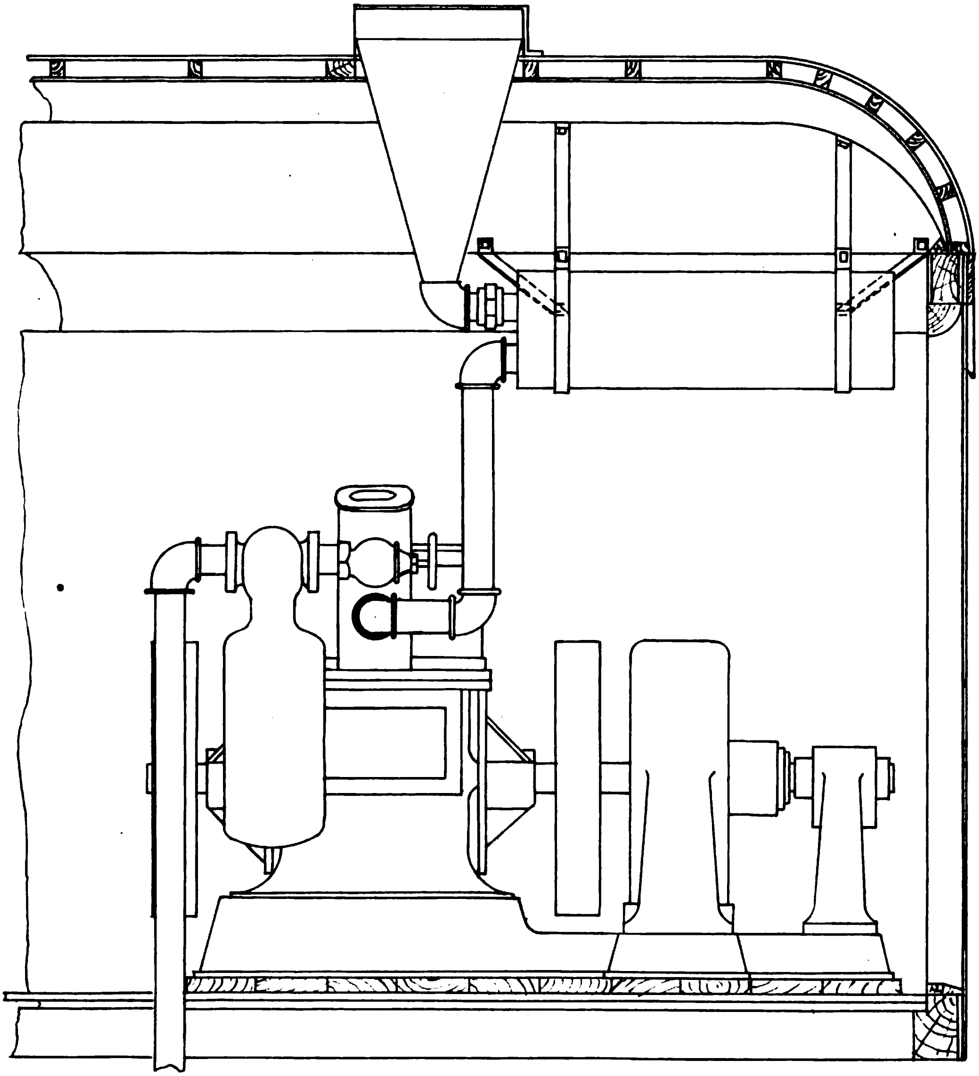


STEAM CONNECTIONS PLATE THREE.

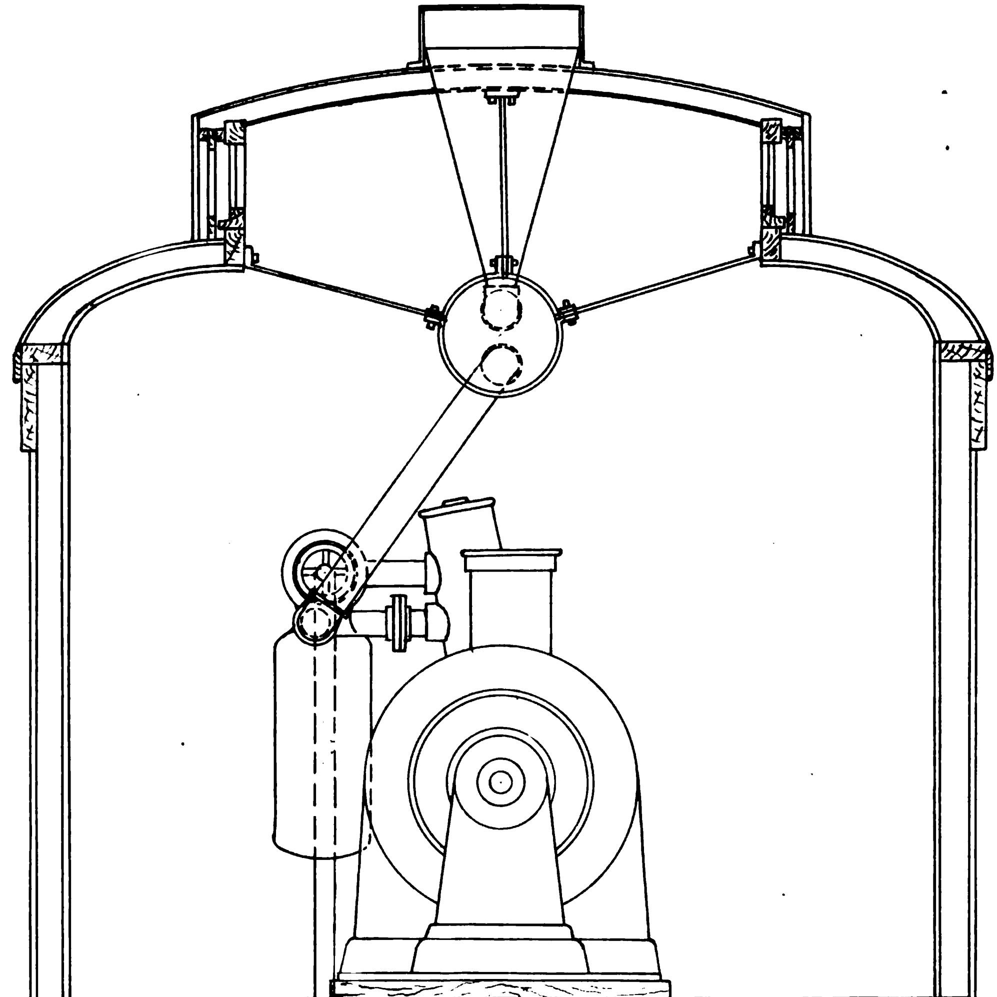


WIRING DIAGRAM OF A 70 Ft. FIRST CLASS COACH.

PLATE FOUR.



ENGINE And GENERATOR
PLATE ONE



ENGINE And GENERATOR.
PLATE TWO.

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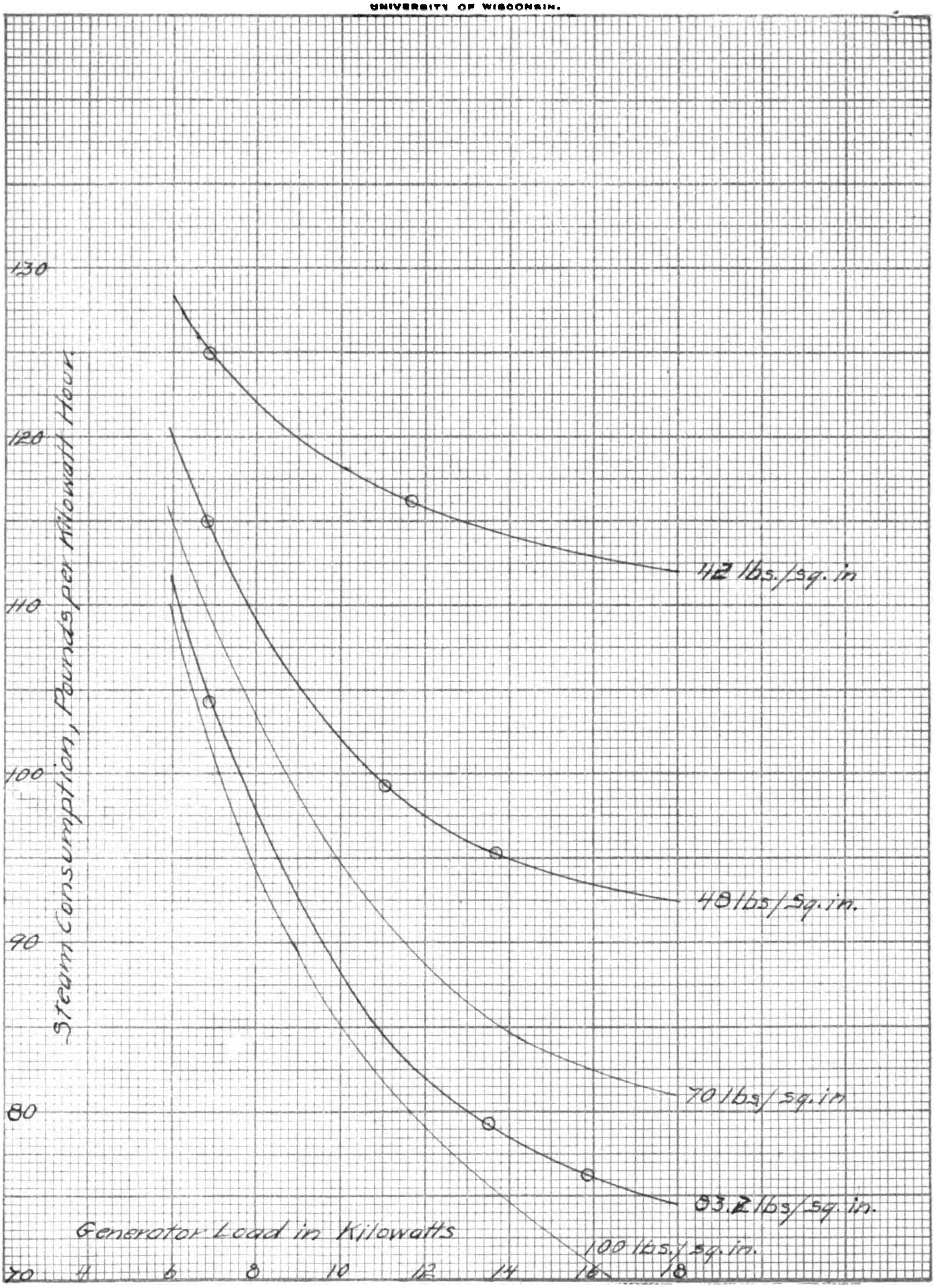

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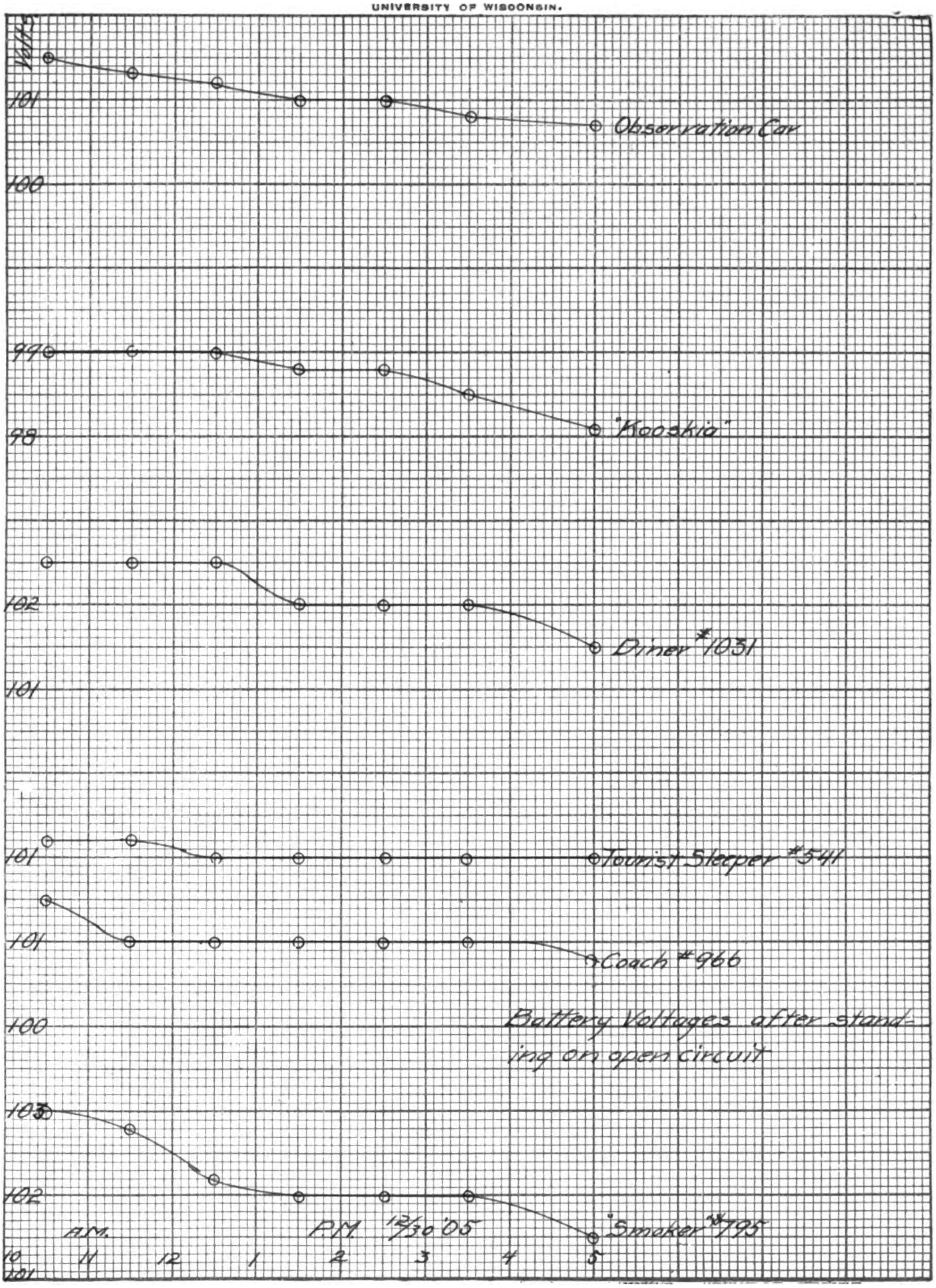
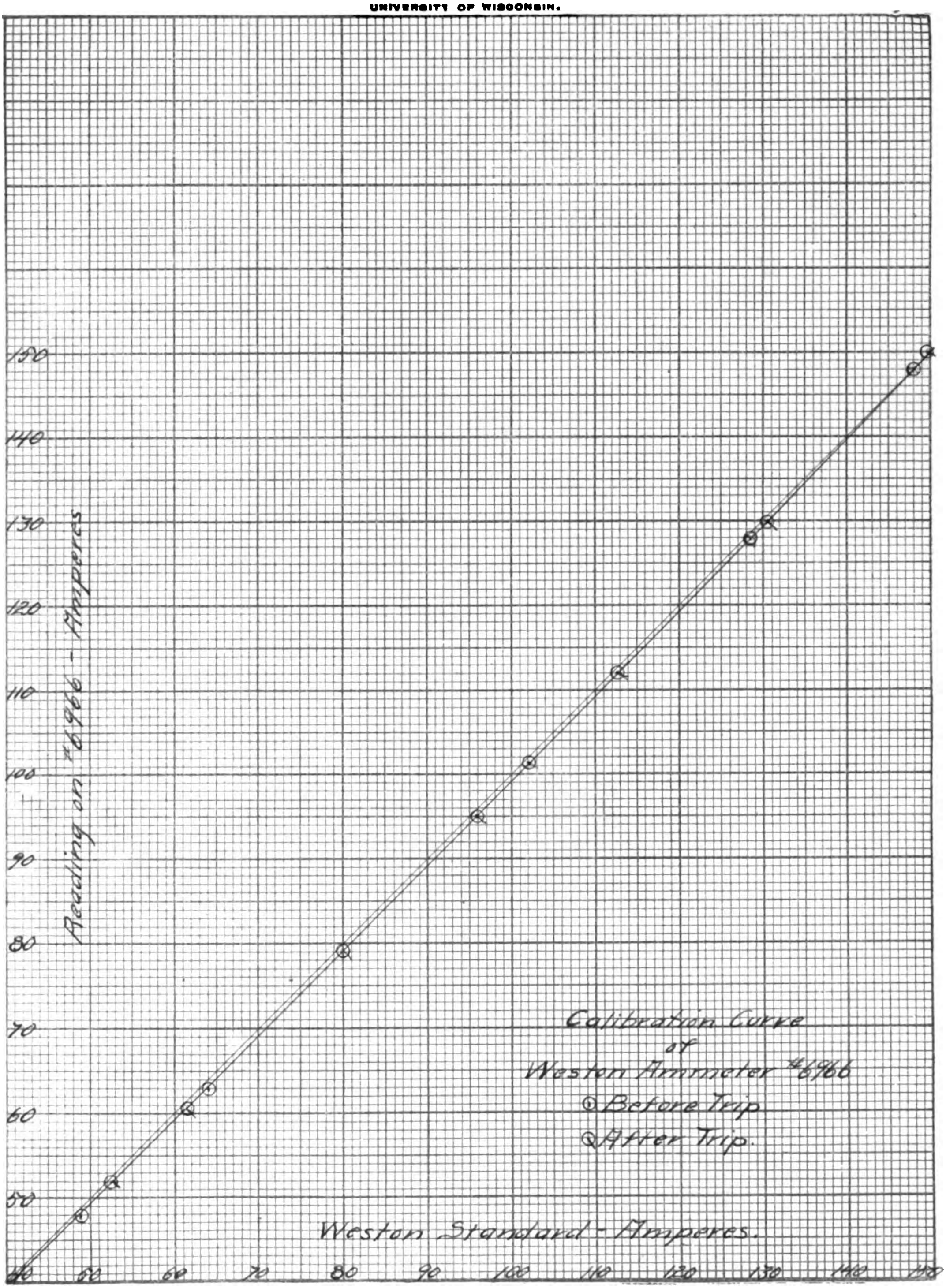
UNIVERSITY OF WISCONSIN.



Battery Voltages after standing on open circuit

COLLEGE OF MECHANICS AND ENGINEERING.

UNIVERSITY OF WISCONSIN.



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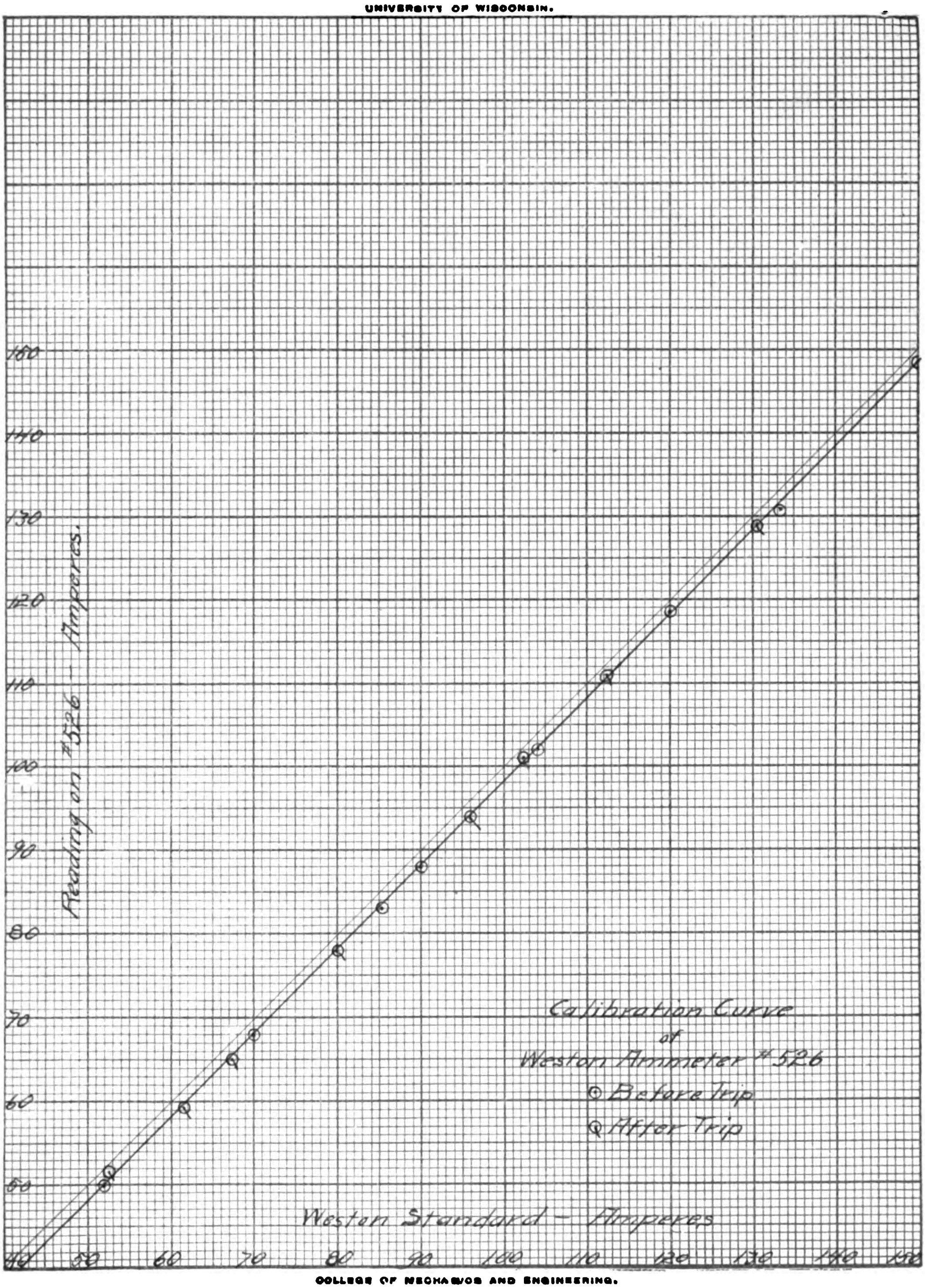
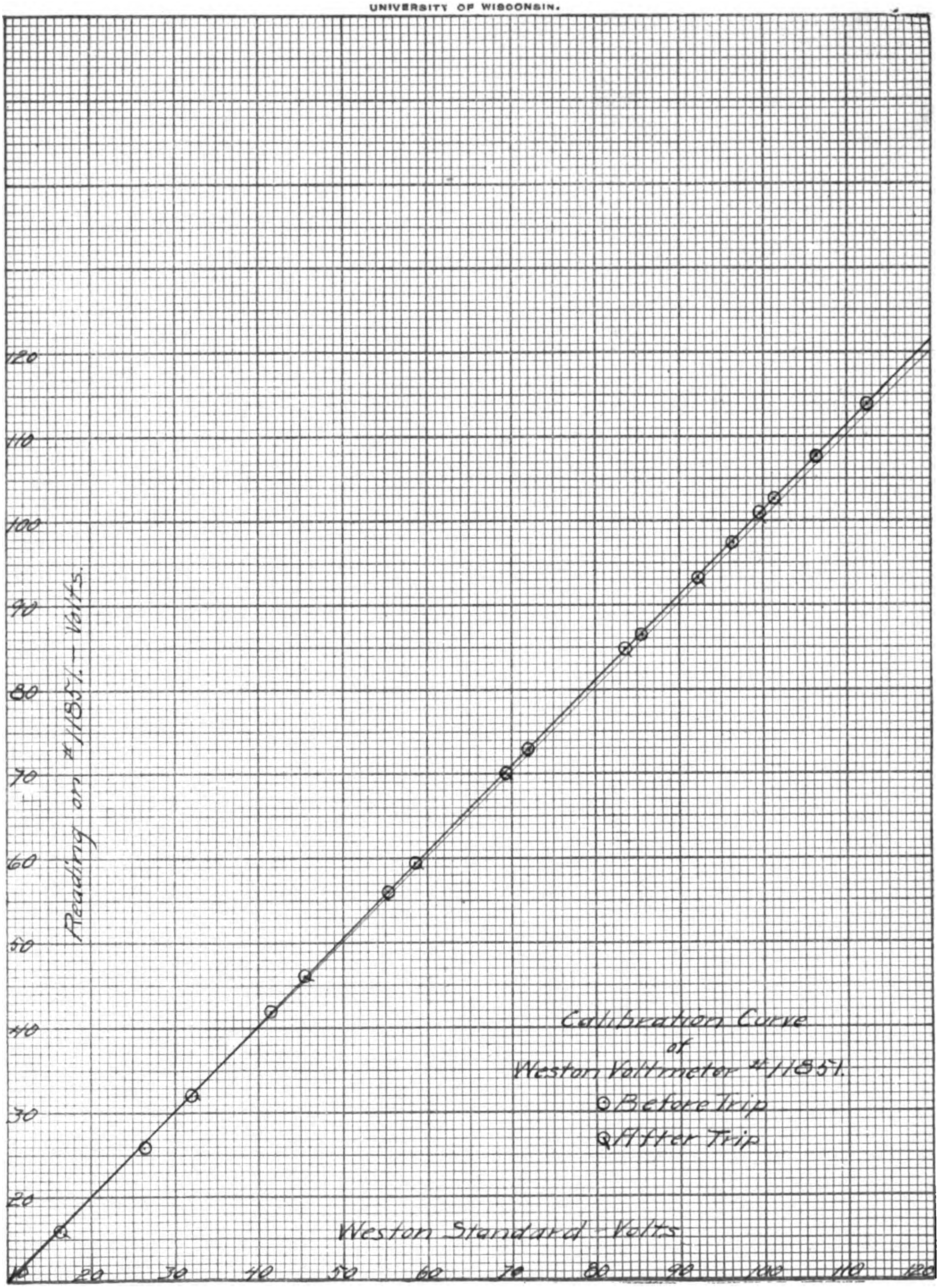
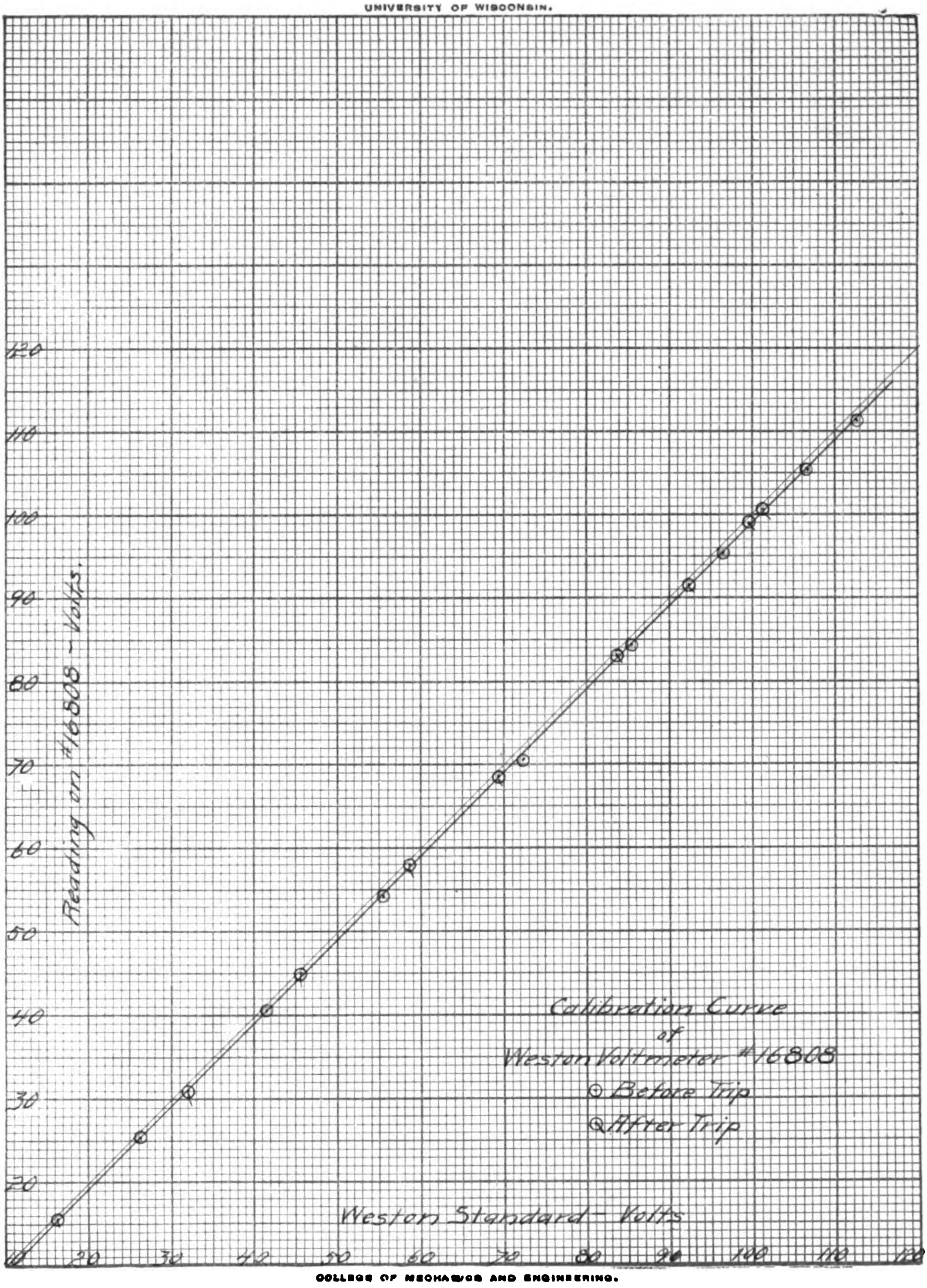

UNIVERSITY OF WISCONSIN.
Calibration Curve
of
Weston Ammeter #526
Before Trip
After Trip
Reading on #526 - Amperes.
Weston Standard - Amperes
150
140
130
120
110
100
90
80
70
60
50
40
50
60
70
80
90
100
110
120
130
140
150
COLLEGE OF MECHANICS AND ENGINEERING.

UNIVERSITY OF WISCONSIN.



COLLEGE OF MECHANICS AND ENGINEERING.


Calibration Curve
of
Weston Voltmeter #16808

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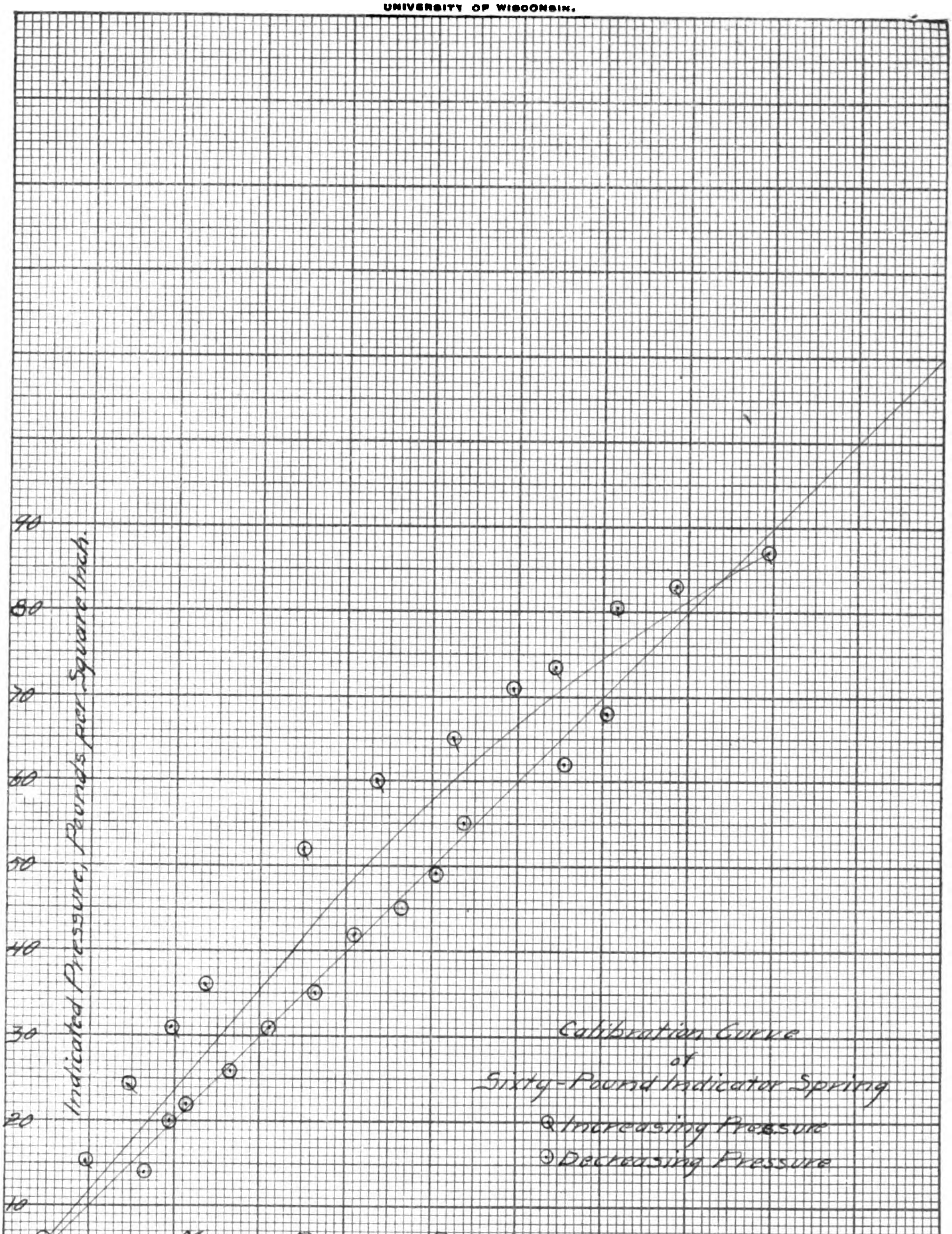
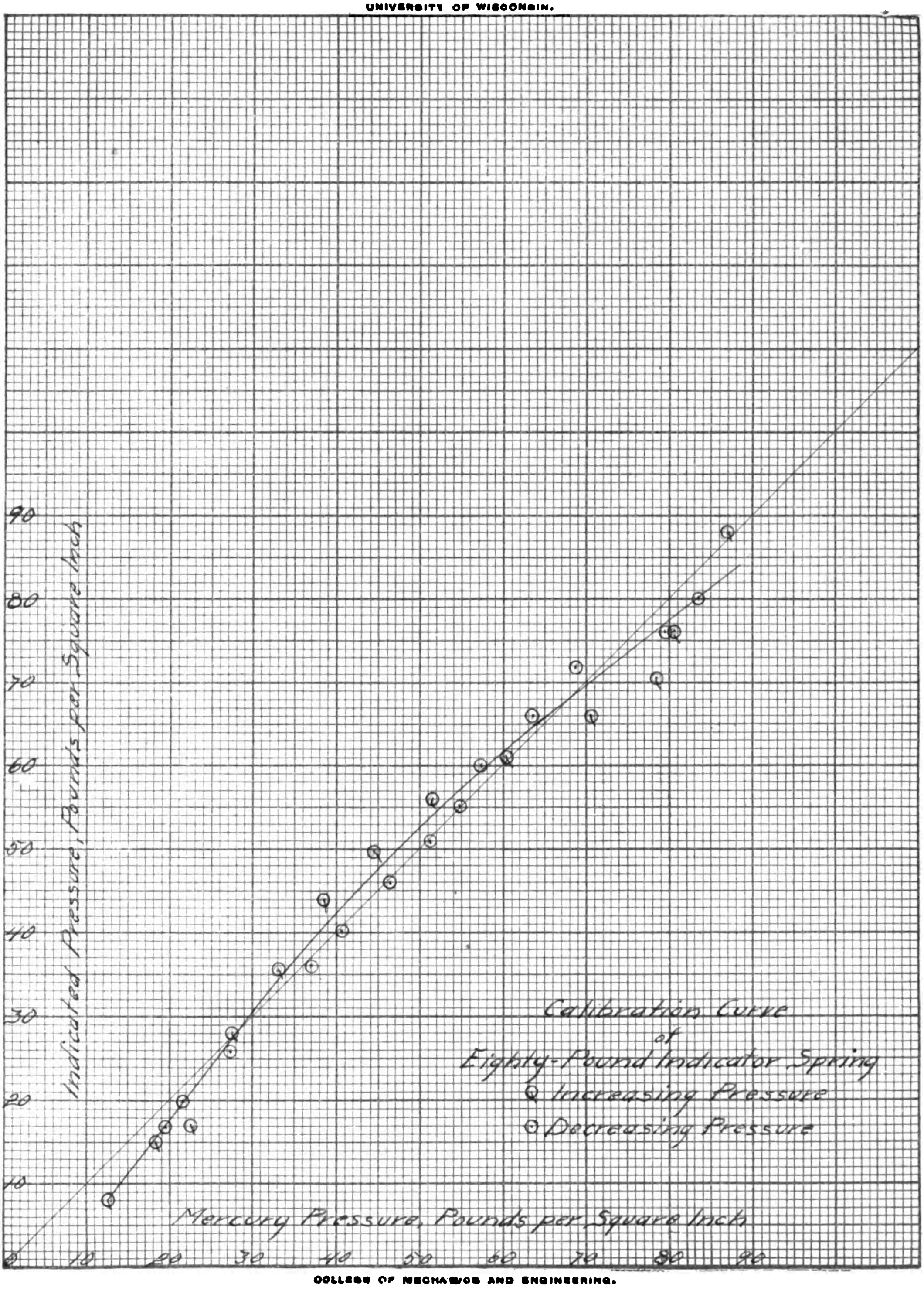


Calibration Curve
of
Sixty-Pound Indicator Spring

COLLEGE OF MECHANICS AND ENGINEERING.

UNIVERSITY OF WISCONSIN.



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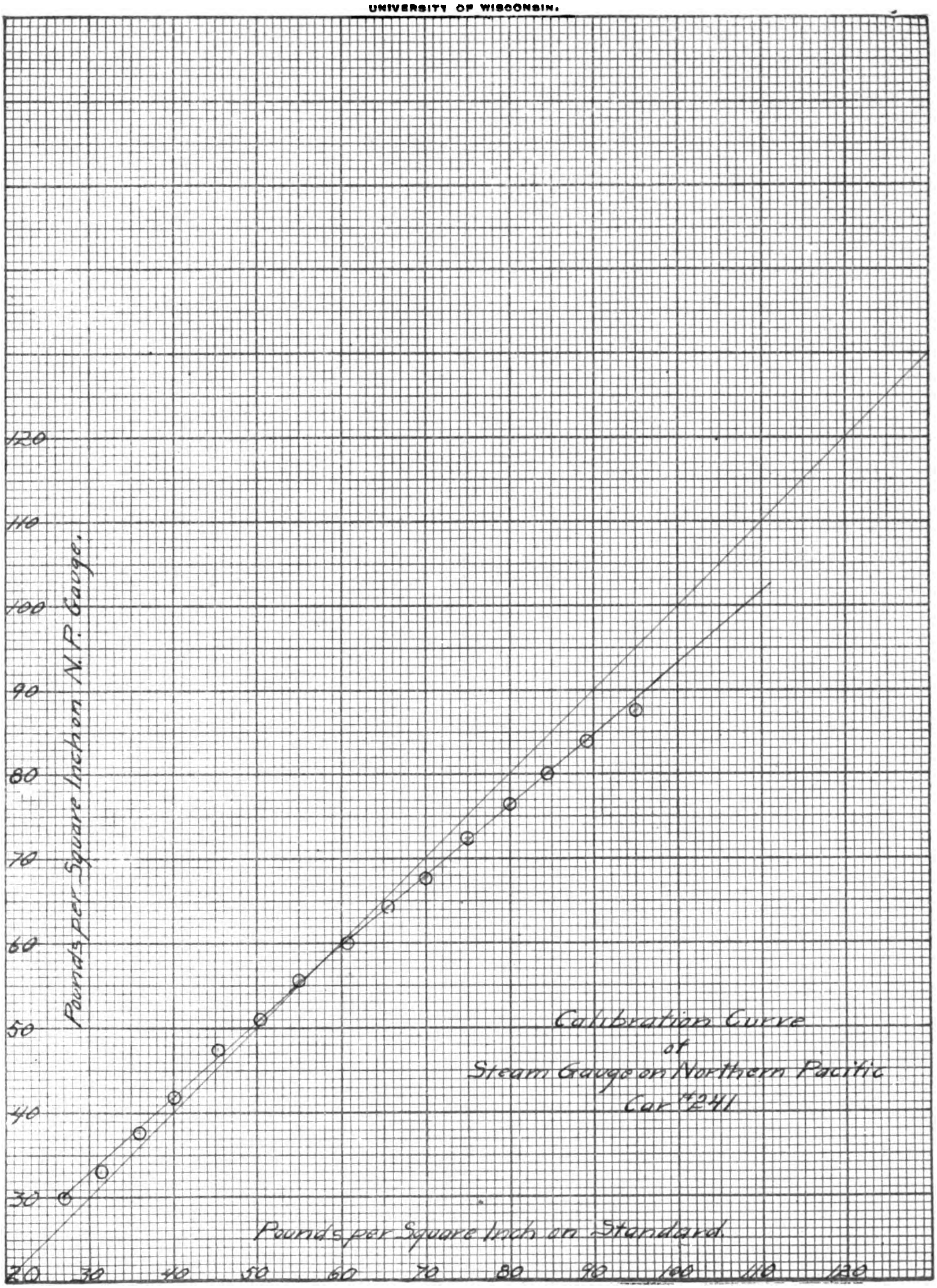
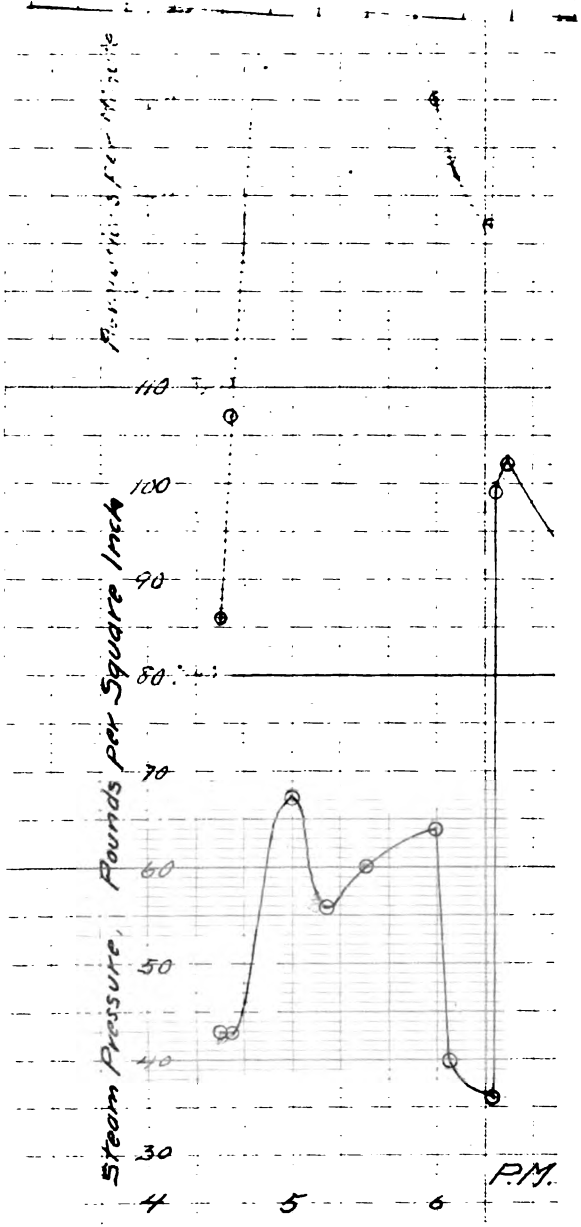


Calibration Curve
of
Steam Gauge on Northern Pacific
Car #241

COLLEGE OF MECHANICS AND ENGINEERING.

Approved Dugald C. Jackson

Professor of Electrical Engineering



First night West Car 241.

89085087534

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